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"Roads and Streets" Passes the 15,000 Mark

The paid circulation of "Roads and Streets" now exceeds 15,000. Our goal for next January is 20,000, and there is every likelihood that we shall attain it.

The amazing growth of the highway industry is well indicated by these circulation figures. The leading monthly magazine of general circulation in the civil engineering and contracting field is "Engineering and Contracting," with a paid circulation in excess of 25,000. The fact that a highly specialized magazine like "Roads and Streets" has 55 per cent as many paid subscribers as the leading civil engineering monthly is the best of evidence that road building and maintenance have become the largest branch of the civil engineering field.

Forty years ago railway construction held this enviable position. The motor car was then "an impractical novelty." George Selden, the builder of the first motor car, told the writer in 1897 that his first gasoline car had ponderously navigated the streets of Rochester about 13 years before. He had insufficient capital to perfect it; but he had filed an application for a basic patent, which, as we recall it, was granted in 1898. Being a patent attorney he realized that a long and expensive legal battle faced him. He hoped to avoid such a contest by charging a royalty that was almost nominal, namely one per cent of the selling price of each car. Although nearly all the manufacturers of automobiles were subsequently induced to pay this royalty rather than litigate, two or three fought the patent and eventually defeated it, but not before Selden had collected several millions in royalties.

The writer secured the first or second state-aid road contract in New York state about 30 years ago. The "Empire State" had appropriated the royal sum of $50,000 a year for state road building; and not without vigorous rural opposition was the road bill passed by the legislature. At that time the only highway magazine (which had been founded in 1892) had so few subscribers that it preferred not to mention the number. Only three states had passed state-aid road bills, and had barely begun road construction. The leading civil engineering magazine was editorially opposing state-aid as being paternalism. The only road magazine was also opposed to state-aid. In fact not a single magazine in the civil engineering or construction field espoused the cause of state-aid until the writer founded "Engineering and Contracting" in 1906, and launched an editorial campaign in its favor.

The husky offspring of "Engineering and Contracting," namely "Roads and Streets," now salutes its parent, and challenges it to a race for circulation supremacy.

Will Texas Operate Cement Plants?

The Texas legislature is conducting an investigation to determine the feasibility of putting the state into the business of manufacturing portland cement. We suggest that they start with an inquiry into the cost of operating the cement plant that Los Angeles operated during the building of its aqueduct. The plant was offered "very cheap" to the county of Los Angeles, which had just begun to build roads on an extensive scale, but the county supervisors declined the offer. One of the former supervisors informs us that an engineering investigation of the cost of manufacturing cement with the Los Angeles plant showed costs much greater than the market price of cement.

State and federal legislators are rarely men who have had much business experience, and to such men the successful conduct of any business enterprise often seems to be merely a matter of having capital. So they are prone to favor socialistic schemes, such as public operation of cement plants, steamship lines and what not. Only the other day the U. S. Senate refused to declare itself against government operation of a merchant marine, in spite of the fact that our post-war experience along that line has been a heavily losing venture for almost ten years. However, a salient characteristic of many legislators is inability to weigh economic facts even when the data are easily available. If the data are not easily to be had, then they almost never search for the information.

America is the least socialistic of all governments, and its people are far and away the most prosperous. This, we believe, is not a mere coincidence. Our neighbor Canada is much more socialistic, and less prosperous. In that case it can not be argued that difference in natural resources accounts for difference in prosperity. Canada's steady loss of population to America is excellent evidence of the difference in prosperity. Men naturally tend to seek the best market for their

services, and the best market is where general prosperity is greatest.

Coming back from general principles to state ownership of cement plants, how does it happen that cement is so frequently suggested as a thing to be manufactured by a state? Why not go into the business of manufacturing crushed stone? Or asphalt? Or brick? Or lumber? Or pipe? Or steel? Well, if any state does get deep enough into the making of cement, and can keep its unit costs successfully hidden, probably it will not be long before its officials will be urging state manufacture of most of these structural materials.

Why stop there? The state could also make machinery of all kinds. Indeed, not long ago the mayor of one of our large cities was advocating the manufacture of water meters by the city.

Might it not be a good plan to give all our socialistically inclined legislators a free trip to Russia? They could there behold all that America is not, a completely socialized state.

Is Unemployment Increased by Machinery?

A writer in the New York Times gives statistics purporting to show that machines are driving men out of work. He cites 14 industries in which greater outputs were attained with fewer men in 1927 than in 1923. Probably there has not been a time in the last century when the same sort of evidence could not have been produced, yet, somehow, although our per capita productivity is five fold what is was a hundred years ago, our workmen find employment more continuous and five times as remunerative.

It is true that overproduction exists in certain industries as a result of the use of better machinery on a larger scale. But there is nothing new in such a condition. Indeed it seems inevitable that many managers will overestimate the demand for their products and expand their plants too rapidly. Not long ago statistics were published showing that the net earnings of the five leading steel companies had not averaged 5 per cent annually on their invested capital since the world war ended. This coupled with the continued very low price of steel, is conclusive evidence of over expansion in steel manufacture. It has been suggested that one of the causes of such over expansion has been the failure to distribute much more than half the profits, the remainder being used to enlarge the steel plants. Had most of the profits been distributed as dividends, stockholders would have been slow to reinvest in a business that was showing only 5 per cent annual net earnings on the invested capital.

Perhaps the most potent deterrent to overexpansion will be the universal publication of production statistics and stocks of goods on hand. If this were done, and if the facts were given prompt publicity, fewer managers would make the mistake of enlarging their plants too rapidly. In addition it would be well if all industries published complete data as to plant capacity, present and prospective.

The latent demand in most industries is quite limited. As we pointed out 15 or more years ago, this is particularly true of farming. The human stomach can hold but slightly more than a pound of solid food, and can digest but three hearty meals daily. Since population increases only about 1.5 per cent annually, food consumption can not increase faster than at that rate. Hence for food products as a whole, the future demand is easily calculable. Here is an industry in which no lowering of prices can increase general consumption. All that price changes can effect is to divert purcha from one kind of food to another.

In striking contrast with farming is the manufact ing of motor cars. Lowering of price has enormous increased demand, and the end is not yet. Americ now headed toward the goal of two cars per f Already Los Angeles county has one and one-thi per family; and where Los Angeles has led in ... car use, other American communities have not b long in following.

Construction of roads and pavements still lags behind the sales of motor cars. So highway impro ment is an industry that could well absorb all the wor men normally idle in America for years to come. T same is true of home building, in so far as late demand is concerned. The economic problem th becomes one of arousing the demand by adequate pu licity, and of financing the desired improvements. stallment purchases of homes on easy terms is alre operating to expand the building industry. Gasoli taxes have aided greatly in providing funds for ro building. So we are learning how to expand tho industries in which a great latent demand exists. W should coincidently learn how to avoid expanding th industries in which the latent demand is relativ small.

H. P. Gillette

Road and Street Men's Reference Book

To render a vital service to the buyer and specifier of road equipment, materials and supplies, and to promote the sales of manufacturers' products, the ROAD AND STREET CATALOG AND DATA BOOK was established.

This authoritative reference work has proved a great benefit and and indispensable companion to highway engineers and officials and contractors. One municipal engineer estimated that 50 per cent of the specifications for roads and streets, especially in the smaller cities, towns and counties would be built from specifications taken from this book.

The data sections include as much matter as a 500-page handbook treating the subjects of design, construction and maintenance of highways and streets. This material has been prepared under the direction of Halbert P. Gillette, engineering economist and editor, and constitutes the most complete and authoritative compilation on highway work ever developed.

This reference work enables the road engineer to keep abreast of modern practice, to observe the results in accomplishment and time saving of the various new machines employed. The catalog also meets the need of the modern highway contractor who is always on the lookout for the latest in labor saving equipment.

In short, this work is a great time saver to the engineer and contractor and is so indispensable that it is commonly carried about by them and kept on the job for handy reference.

The Law of Sunspot Periodicity

By H. P. GILLETTE
Editor

Free electrons in motion cause an electric current and electromagnetic effects. Matter contains free electrons, the number being a function of the nature of matter, its mass, and its temperature, and an inverse function of the pressure. Hence an axially rotating mass, like a planet, produces an electromagnetic effect. If the axis of such a magnetic field is not coincident with the axis of the planet, and if it rotates backward, the maximum magnetic effect on the sun will occur at intervals less than the orbital period of the planet. Hence if sunspots are caused by the electromagnetic action of a planet the sunspot periods will be shorter than the planet's orbital period. If we assume that the poles of the electromagnetic field rotate backward as a result of encountering a less resistance on the side nearest the sun than on the side farthest from the sun, which difference is proportional to the square of the orbital velocity of the planet, then it can be shown that

t=T (1-kv).

t=sunspot period due to a planet.

T=orbital period of the planet.

v=its orbital velocity, miles per second.

k=constant=0.007 nearly.

The value of k above given is such that the deduced values of t for the eight planets give theoretical sunspot periods that are in close accord with actual periods discoverable on a sunspot chart and on a tree-growth chart, excepting only the planet Mars, whose sunspot period is somewhat shorter than indicated by the formula.

Certain comets at and near perihelion cause sunspots which have served to confuse the searcher for sunspot periodicities.

The electromagnetic effects of the rotating masses that constitute the cyclonic storms called sunspots, produce atmospheric disturbances akin to convection currents, for the ionized air is attracted or repelled according to whether it has unlike or like polarity to that of the sunspot.

In a later article the formula above given will be deduced, and supporting data will be presented.

D. A. Garber New General Manager of Associated General Contractors

The construction industry soon will see a change in its leadership when Gen. R. C. Marshall, Jr., resigns as general manager of the Associated General Contractors of America, a position which he has held for eight years, and in which he will be succeeded by D. A. Garber, of New York, one of the best known construction men in the United States, who was the first president of the contractors' organization, which he helped to found. The change will take place May 1.

Gen. Marshall is resigning from his position as executive head of the A. G. C. to become president of the Sumner Sollitt Co., Chicago. His new affiliation will link him with a construction organization which is among the largest in the country and which has operated in England and in this country for five generations.

Mr. Garber, in making the change, severs his connections with the North-Eastern Construction Co., New York, of which he has been president since 1904, and which has engaged in many major projects in states along the Atlantic seaboard.

Each of the principals involved is known throughout the length and breadth of the construction industry.

Gen. Marshall, as war-time chief of the construction division of the army, was in charge of the emergency military building program of the nation, which involved hastened provision of cantonments, munition plants, warehouses, power units, shipping bases and many other types of projects made necessary by preparation of the national army for overseas service. Experience gained from direction of these activities and the broad acquaintances which Gen. Marshall established with the nation's construction men during those hectic times, naturally equipped him well for the post of general manager of the A. G. C. to which he later was appointed.

From the moment when the idea of forming a contractors' national association was started on its way to realization, Mr. Garber has held a leading position in the movement. He played a prominent part in the association's preorganization meetings at Atlantic City and Chicago, and, as first president of the body, guided the association through its earliest days of pioneering. During the past decade he has exercised an active leadership in the body's efforts to clear away muddled conditions in the construction industry, at the same time continuing supervision of the construction company which he has headed for more than a quarter of a century.

Thus, by severing his private interests in construction to become executive head of the organization which he helped to found, Mr. Garber is entering into active leadership of a program which he largely inspired and with which he constantly has been associated during recent years.

Gen. Marshall's resignation was submitted to the executive board of the association and was approved by that body at a meeting recently held. At the same time, Mr. Garber was unanimously appointed by the members of the board.

Pedestrian Control

The police department of Detroit, Mich., is issuing bulletins on the general features of the traffic situation in that city, the information being taken from the department's traffic survey bureau report. One of the latest of these bulletins deals with pedestrian control. We quote from the bulletin as follows:

"Of all the phases of street traffic, without a doubt that of pedestrian control is the most difficult for which to prescribe a remedy. The pedestrian in full recognition of his own safety and of the efforts made for his safety, invariably insists on exercising his inalienable rights to govern his own action either on the sidewalks or in the roadway.

"It has been said that if vehicular traffic was permitted to function in a manner similar to that elected by pedestrians, highways would be in a hopeless tangle. And yet, the pedestrian realizes full well that insistence upon doing as he pleases is at times dangerous to him, and to others, and produces obstructions to vehicular traffic.

"The peculiar thing about it is the intolerance that exists between vehicle operators and pedestrians. This attitude might not be so surprising if there were a well defined line of demarcation between the two classes, which does not happen to be the case. Some time during the day, every motorist, with a few possible exceptions, has occasion to adopt the role of pedestrian. Many pedestrians, too, have occasion to operate motor vehicles and because of this exchange of roles, there would be expected a mutuality of interest, especially for reasons of personal safety, if for no other. Yet, this much desired condition does not exist and hence a rather senseless problem to try to solve.

"Some municipalities have attempted pedestrian control through the medium of ordinances with penalties for infractions thereof, while other cities have tried giving the pedestrian a right of way at all times. Both of these schemes have certain drawbacks, the principal one being the use of a penalty or a premium to make people do what their own common sense teaches them they ought to do of their own accord.

"Where pedestrian control has seemingly been impossible, other means have been suggested, such as pedestrian subways, overhead bridges, and schemes of a similar type, all of which cost money, require considerable time for installation and are only justifiable when the traffic density, pedestrian, vehicular or both, is so great as to preclude the adoption of any other course.

"Even though pedestrian subways and bridges were the only means available for providing a solution, it is man-

ifestly impossible to construct them all at one time for physical and financial reasons. In addition, it is not a foregone conclusion that pedestrians would use them unless there were no option in the matter or else the subways were so attractive structurally that people would want to use them.

"The compulsion idea is rejected as being impracticable. The idea of use based upon attractiveness is accepted with the proviso that proof thereof must be established through trial. For instance, the mere construction of an underground passage without special attention being given to illumination, ventilation, easily negotiated approaches, personal safety of the users and proper location of subway entrances would most certainly not fall under the heading of attractiveness. Therefore, it would seem reasonable to decide upon a location for one pedestrian subway, design the same with regard to the items enumerated above, place it in commission and then carefully check the results.

"If the pedestrian could be divorced from the element of impatience, much of the trouble would disappear. This is particularly noticeable at intersections, the traffic at which is not controlled either by signals or police officers. Many times a slight wait of a few seconds on the part of the pedestrian would be all that is required. Impatience is also a pronounced pedestrian characteristic at controlled intersections and that the unwillingness to proceed in accordance with the signal indications actually is a liability is shown from the following:

"The records of the Accident Investigation Bureau for the first four months of 1927 show that 67 per cent of the fatal accidents and 67 per cent of the injured pedestrian accidents occurring at signalled intersections were pedestrians crossing the red signal. Tallies made at three intersections on Woodward Avenue show that 45 per cent of the pedestrians crossing these intersections crossed against the red signal.

"That an automatic pedestrian control device would be of any use is a matter of opinion and is simply mentioned here as one of the many suggestions received on the subject of traffic control and regulation in general.

"One phase of pedestrian control which has not been given the attention it merits is that of locating signals, which pedestrians are expected to obey such that the signals are in their direct line of vision. Only in exceptional cases will pedestrians watch the signal aspects if it requires the slightest physical effort so to do. An acknowledgment of this fact might just as well be made and signal systems arranged so that this feature is taken care of even though it may call for additional equipment.

"The appellation 'Jay Walker' has been applied to the person who, for various reasons, crosses the street at points other than where crosswalks are located. The 'Jay Walker' is a liability, not only because of the potential accident hazard to himself and also to vehicles, but because of the interference with vehicular movement brought about by his use of space where he is neither expected nor wanted. In other words, one less attention-diverting element would be removed from the motorist, the accident hazard would be reduced and one traffic retarding item would be removed, if pedestrians would or could be prevailed upon to cross the streets only where there are crosswalks.

"For the first four months of 1927, of the total pedestrian fatalities and injuries in Detroit, 42.4 per cent of the fatalities and 54 per cent of the injuries were directly traceable to the 'Jay Walking' class.

"There is no yard stick for measuring the 'distemper' caused vehicle operators by the 'Jay Walkers' in the narrow escapes from collisions, nor can there be measured concretely the obstructing action such individuals have on the desired condition of 'fluid' traffic movement."

Workability of Concrete

(From the March Technical News Bulletin)

A summary of the study of the methods for measuring the workability of concrete which has been conducted at the U. S. Bureau of Standards was presented at the convention of the American Concrete Institute at Philadelphia, Feb. 28 to March 1.

The plastic properties of neat cement pastes were first studied, by measurements of the velocity of a ball pulled through the paste. This apparatus gave data of interest but could not be applied to the study of the workability of concrete. Next, a study of the separation of the concrete on the flow table was made. After flowing the concrete was divided into two equal areas by two concentric circular cutters. The volume and weight of aggregate coarser than the No. 4 sieve in each portion were measured, and the workability figure calculated as a function of these measurements. Several shapes of flow table and heights of drop were used. There was an indication that the best results were obtained with the flat top table operated with a 1/16-in. drop. This method was not, however, found completely satisfactory, since the influence of mixing time could not be determined. The next method which was used measured the internal resistance to shear of the concrete by the deformable cylinder, as described in Technical News Bulletin No. 114, Oct., 1926. The results obtained with this method were encouraging but did not show a marked difference in workability of lean concrete mixes. The final study was made with a modification of the Pearson and Hitchcock penetration rod apparatus. This apparatus was modified by making each drop of the weight a constant and then by increasing the number of rods from 1 to 3. This apparatus has given the most satisfactory index of workability thus far obtained.

The principal results obtained from the tests may be summarized as follows:

1. The workability as determined by the separation of the concrete on the flow table was not satisfactory for several reasons. The individual measurements varied too greatly, the measurements on mixes of different proportions did not show markedly different results, and the personal element also entered too markedly into the tests.

2. The deforming cylinder apparatus did not measure the workability of lean mixes of different proportions distinctly and conclusively, nor was the test sensitive enough to measure the effect of increase in the mixing time upon the workability.

3. The modification of the penetration rod apparatus by driving in the rod by a falling weight instead of by the inertia of the rod when the whole apparatus was dropped has eliminated the compacting of the aggregates and, together with lightening the rods and driving weight, using three rods instead of one, and the use of a larger mold, has increased the precision of the tests. This apparatus is capable of measuring the influence of increased mixing upon the workability and measures the difference in workability of lean mixes with different gradations.

The studies are being continued.

State Highway Equipment to Be Painted in Red

All road equipment of the State Highway Department of New Mexico, such as graders, trucks, tractors, etc., is to be painted a uniform color—a bright red.

The reasons for this move are several:

First, equipment painted a bright red offers great visibility to motorists and therefore lessens the probability of accidents caused by drivers running into pieces of road machinery.

Second, by having all state road equipment of a uniform color, it is readily recognized and identified. Thievery of such equipment would be more hazardous and stolen equipment could be easily identified and quickly recovered.

As rapidly as machines are brought into the state highway shops for repair, they will be painted the standard "highway red" before being returned to the job. In this way the painting of machinery will take place gradually and there will be little inconvenience due to shortage of equipment.

Method of Constructing Surface Treated Roads In Hillsborough County, Fla.

Construction Features of Recently Completed 89-Mile Highway

By P. F. ROSSELL

TO Northern engineers, some aspects of the location and construction of roads by Hillsborough County are unique. It may, therefore, be of interest to describe a project just completed.

Location of Work.—This project, located in the 5th Commissioners District, which comprises about one-third of the entire county, included 89 miles of highway as follows: Brick with asphalt filler 36,709 sq. yd.; shell base with sand covered surface treatment 51,649 sq. yd.; Florida lime rock base with slag covered surface treatment 715,838 sq. yd.

Structures.—Concrete culvers were of the standard box type offering nothing unusual in design or construction. Several locations were encountered requiring special study due to existence of muck. In practically all such cases the depth of muck was determined and piles jetted to secure proper bearing. In some cases where the muck was not deep, it was removed and the culvert carried down so as to bear directly on suitable material, usually sand or hard pan.

All bridges were of standard timber construction, 20 ft. clear roadway, four pile bent, 15 ft. centers, 4 x 12 stringers, ten to the span. In all cases piling was jetted and bearing was secured either on stiff clay or rock. Due to the lack of high water during construction, this work progressed in a rapid and economical manner. This item was not included in the general contract but was executed under direction of the writer with local labor. For this work an appropriation of $67,000 was allowed. Cypress timber and piling were shipped to a central point and creosoted by us by dipping. This gave fair results. The bridge crew consisted of one superintendent, one foreman and nine men. Speed was obtained by the men camping at the various bridge sites. In addition to the usual small tools, the following comprised the complete outfit used by this gang: One Ford truck and trailer, one A-frame, one Fordson tractor and one 3-hp. Fairbanks-Morse engine and pump, 2 in. feed and ¾ in. jet.

Surveys.—The contract was let before any preliminary studies were made and surveys and construction began practically at the same time. Even with this handicap no serious obstacles or delays were met. Practically all of the location followed land lines and this facilitated and speeded up the work.

Section of Asphalt-Filled Brick Highway

Our right of way is 60 ft. with fences set back 32 ft. from the center line. This was increased at certain places where it was necessary to widen out in order to secure the required amount of material for fills. In these cases, a berm of about 10 ft. was left intact outside the toe of slope. In these cases we were fortunate in securing a good sandy material for the fills.

Excavation.—As a general rule our excavation is rather light but some of our fills at river crossings were heavy. In some cases change in river channel necessitated considerable excavation. Heavy fills were thrown up at the beginning of the job, thus getting advantage of the rainy season. It is necessary to exercise great care to remove all clay from the subgrade.

We have had cases where, notwithstanding conscientious foremen and inspectors, clay balls have worked from the subgrade completely through the rock base within 24 hours. Due to honest cooperation of the contractors these defects were detected and promptly corrected. In this connection I might say that I have seen clay being removed from the surface of roads in Florida, which roads have been under traffic for upwards of two years before the clay worked to the surface. The total yardage moved by the contractor in grading for the highway amounted to 630,000 cu. yd.

Drainage.—Due to the flat nature of the country traversed, quite an elaborate system of lateral ditches was necessary to insure protection during the rainy season and to aid in lowering the ground water level. A great many of these ditches were dug with the county's dragline by our own forces.

Construction of Lime Rock Base.—Stakes were set to line and grade 11.5 ft. off center, as this distance proved most convenient for the contractor. Form boards 2 in. x 8 in. were set 7.5 ft. from center line to inside of board, so as to insure our full 15 ft. of road. After the form boards had been set, the subgrade was watered thoroughly and where possible, rolled, then checked by means of a templet. The base for the brick road and the sand covered surface treated ones were of shell and the same treatment of subgrade and material was followed as with Florida lime rock base. The most interesting and unique feature to a Northern engineer is the lime rock base, sometimes called Ocala lime rock, due to the fact that numerous quarries are operated near the town of that name in Marion County, where this rock was first mined in 1884. This material is almost pure limestone, so much so, in fact that our specifications require the contents to be 97 per cent pure lime. It is furthermore required that it shall be free of clay, sand and other impurities. Inspection of each car is most rigid and none can be unloaded until thoroughly inspected. Although these requirements appear to be and in fact are rigid, out of the entire quantity received on this project, only 20 cars were condemned.

It is rather a simple matter to tell when a shipment meets the specifications due, no doubt to the fact that when the rock is dirty, this is caused by clay pockets in the quarry being

Section of Highway Which Received 2-Course Surface Treatment

blown down and mixed with the pure rock. Usually when this happens, it is in such quantities that it is easily detected. When working in a face free of such pockets almost pure limerock is produced.

The rock is hauled from the railroad siding in dump cars and deposited upon the subgrade. In no case are the trucks permitted to pass beyond the rock already spread. Great care must be exercised to keep the rock clean and to so dump, spread and work it that no sand will become incorporated with it. Sand is usually mixed with the rock during construction, either by the loaded truck rocking back and forth in dumping, causing the sand to squeeze up adjacent to the wheel or by the trucks running outside the form boards and whipping sand onto the rock base.

Care must be taken that all sand pockets are dug out and this material thrown outside the forms before scarifying and blading are done.

The rock was spread either with forks or round pointed shovels, sometimes supplemented with a Russell grader. The combination of shovels and grader gave the best results. Considerable experience is required to properly work Florida lime rock and even the famous "20" year men will make glaring errors unless properly supervised.

After the rock is properly spread, water is added to it while still open and until it is thoroughly wetted, then it is rolled, scarified and bladed and this operation repeated until the base conforms to the proper section. Unless this work is properly executed, defects such as laminations and wavy edges will result.

When edges must be brought up or laminations removed, it is better to re-scarify the entire width of road to a depth of 3½ to 4 in., adding water and fresh rock. When the base receives a final blading, this bladed material should be whipped off the rock base completely; if this is not done, more laminations will result.

Thorough consolidation is secured by rolling with a 3-wheel roller weighing at least 300 lb. per inch of width of wheel.

Some engineers appear to desire a definite quantity of water to be applied to the rock. It has been the writer's experience that this is a question which can be decided only by judging local conditions and the application of sound judgment based upon actual knowledge of just how the rock will act under the conditions encountered. Under some conditions on this job no water was applied to the subgrade and none to the rock, yet the base rutted under traffic and as much as four days continual blading were required before the desired surface could be obtained.

Factors to be taken into consideration are the moisture content of the soil and rock and the weather condition. The rock being of very fine texture invites capillary attraction, especially under traffic. From the above it is seen that no hard and fast rule can be laid down governing the quantity of water to be applied. Frequently sand known locally as ball bearing sand is encountered which holds as much water as a sieve and under such conditions we usually keep the pump going day and night and even then are not satisfied with the compaction of the subgrade secured.

Usually one day's run is worked up and finished on the following day so as to assure the presence of the proper amount of water for cementation. Immediately thereafter the thickness is tested. The average rock base laid by one outfit in one day was 2,000 sq. yd., with a maximum of 3,333 sq. yd.

Prime Coat.—After the base had properly cured and "set-up," which period is dependent upon water content, weather conditions and traffic and meets the specifications in all respects, it was accepted for application of the prime coat. All loose material and foreign matter was carefully removed and Tarvia "B" applied at a rate dependent upon the tightness of the base. Our specifications called for 2/10 gal. per square yard but this quantity was applied only when the base was dry and able to absorb it. During wet weather, it was found that the base would not properly take up more than 15/100 gal. per square yard and this quantity was applied with good results. For the shell base we found that two applications of 2/10 gal. each were required. When possible, traffic was blocked until the prime had thoroughly penetrated the base. Where excess spots occurred and when not possible to block traffic, the prime, after say 24 hours, was covered with clean sand to blot the excess and avoid pickups. After a period of seasoning, which varied from a week to ten days, the road was again swept clean of all foreign material and Texaco macadam binder was applied at the rate of 4/10 gal. per square yard at a temperature of 275 degrees F. This is followed immediately by a covering of crushed slag at the rate of 35 lb. per square yard and rolled with a tadem roller. The top or asphalt was applied during a period of heavy and frequent showers and while we never permitted its application on a wet base, often times immediately after it was laid, heavy chilling rains fell before the slag was applied. The finished job in such places showed a uniform and perfect mat as does the entire job, speaking well for the material and workmanship.

Construction of Brick and Sand Covered Surface Treated Roads.—The brick road was constructed on 4 in. shell base with sand cushion and Texaco No. 39 paving filler. The sand covered surface treated roads were constructed of 6 in. compacted shell. Tarvia "B" applied as noted elsewhere as a priming material and Texaco macadam binder applied at the rate of 4/10 gal. per square yard for the top or seal coat and then covered with triple washed concrete sand.

Bermuda grass was planted on some of the shoulders and as soon as the rains start, this will be continued until the entire mileage has been planted. Due to the sandy nature of the soil, it is a point of economy to grass the berms and slopes as otherwise the cost of maintenance would be excessive.

Unit Prices.—The unit prices bid on this job were:

Clearing and grubbing, per acre	$55.00
Excavation, per cu. yd.	.25
Class "A" concrete, per cu. yd.	28.00
Two course surface treatment, per sq. yd.	.28
6 in. Florida lime rock base, per sq. yd.	.90
18 in. concrete pipe, per foot	2.85
24 in. concrete pipe, per foot	3.65
Re-inforcing steel, per lb.	.06
Shell base, cu. yd.	2.20
4 in. x 12 in. concrete curb, per foot	.45
Old brick laid, per sq. yd.	.50
New brick laid, per sq. yd.	2.50

The general contractor was Smith Brothers Construction Co. of Dallas, Tex., and Tampa, Fla., with T. D. McGinnis as manager and Wm. Taylor, superintendent. W. T. Williams is chairman of the Board of Commissioners for Hillsborough County and Commissioner from the 5th District. A. B. Pimm, County Engineer and the writer, chief engineer on the project.

Power Shovel Operation in Highway Grading

General Requirements Necessary for Efficient, Economical Production

By T. WARREN ALLEN AND ANDREW P. ANDERSON
Chief Division of Management, and Associate Highway Engineer, U. S. Bureau of Public Roads

THE daily cost of operating a power-shovel grading outfit is very nearly fixed for any given set of conditions, regardless of whether the output is high or low. The only effective means available to the contractor for reducing his unit cost is therefore to increase the rate of production.

Coordination of Three Distinct Operations.—Efficient use of the power shovel in highway grading generally involves the proper coordination of at least three distinct operations: (1) Except where the material can be cast, it must be dug and loaded into the hauling units at or near the maximum rate of production for the material handled; (2) the hauling units must be just sufficient to carry the output of the shovel and must be operated with almost clocklike precision, so that the load may be received, transported to the place of disposal, dumped, and the hauling units returned to the shovel without interrupting the steady operation of the shovel; (3) at the fill or dump the material brought by the hauling units must be spread and compacted or otherwise cared for as may be required by the specifications without interfering with the steady operation of the hauling units. If the material is too hard to be dug effectively with the shovel, another operation, that of drilling and blasting, is necessary, and this operation must also be carried on without interfering with the others.

Efficient operation requires not only that a high rate of production be secured with the shovel, but that this production be secured with the use of a minimum of labor and auxiliary equipment. This can only be accomplished when each operation is so synchronized and coordinated that the entire organization functions as a unit without either interference or waste in any of its parts. Absolute perfection in all details is probably impossible. Nevertheless, recent extensive studies by the Division of Management of the Bureau of Public Roads, of power-shovel operation on a large number of projects operated under a great variety of conditions show rather conclusively, (1) that a high degree of efficiency is possible of attainment, and (2) that, in general, the cause of the low production encountered on many projects is due to conditions over which the management has more or less definite control and which are therefore to some extent remediable.

Data collected by the Division of Management of the U. S. Bureau of Public Roads in its studies of power shovel operation in highway grading, indicate that there were few jobs on which a material increase in output cannot be obtained without a corresponding increase in cost. In some cases it was found possible to increase output as much as 100 per cent by a change in management methods. The results of these studies by the Division of Management are being set forth by Messrs. Allen and Anderson in Public Roads, the official publication of the U. S. Bureau of Public Roads. Some of the more general requirements necessary for efficient, economical power shovel production, as developed by the studies, are briefly summarized in the first article. This portion we are reprinting herewith.

On this work the shovel is the primary producer. All production is dependent on it. An inferior shovel or operator is a certain guarantee that production costs will be high. The shovel should be sturdy, powerful, dependable, fast, and easily operated. But no matter how good the shovel, a high grade of skill, intelligence, and endurance is required on the part of the operator in order to secure consistently a high rate of production.

Power Shovel Output.—In ordinary common excavation 4 or more feet in depth and which is dug easily and dumped freely, a good power shovel in good condition can load vehicles at the rate of four dipper loads per minute, providing the vehicles are so placed that the average swing does not exceed 90 degrees. A good operator can continue this rate for intermittent periods throughout the day. To attain this rate it is necessary to load the dipper in about 4½ seconds, to swing and spot the dipper in about 4 seconds, to dump it in 11½ seconds, and then return the dipper to the loading point in about 5 seconds. Many jobs have been found where this rate has been maintained during intermittent periods of varying length under the conditions given above, and it may therefore be taken as the maximum attainable with present-day shovels worked under favorable field conditions. However, numerous jobs have been found where the average rate of all-day shovel operation, in good common, was at the rate of three or more dipper loads per minute, and this may therefore be accepted as a criterion of good operation under normally favorable field conditions. If the operator is forced to swing his shovel 180 degrees instead of 90 degrees, his best possible short time output will be only about 3-1/6 dipper loads per minute even with a very fast swinging shovel, while his all-day average rate may readily be much less than 2½ dipper loads per minute.

Dipper Loads.—Output, however, is the product of the number of dipper loads multiplied by the average yardage per dipper load. A good operator can combine both speed and high average quantity of material. In ordinary common excavation 3 or more feet in depth the average dipper load for a ¾-yard shovel should be about ½ cu. yd. of material as measured in place. A 1-yd. dipper should average about 0.7 cu. yd. In some materials which heap up on the dipper and do not spill on the swing the average load will sometimes equal the rated capacity. In poorly blasted rock or shale, or in material full of roots and stumps, the average dipper load may be 40 per cent less than the general average for ordinary common excavation or about 0.3 cu. yd. for a ¾-yd. dipper. Figure 1 is illustrative of the studies made and shows the rate at which dipper loads can be deposited in the hauling units under fast operation, and how a few slow operations increase the average time per cycle for the entire period. As the material passes from good common to one more difficult the digging and loading operations become slower and there is greater difficulty in securing a full dipper.

Mistakes in Management Found Which Greatly Reduce Profits.—The custom of loading the hauling units at the rear of the shovel (180 degree swing) is a very expensive practice. Even with a fast-swinging shovel, loading at the rear of the shovel instead of at the side will increase the time required for each dipper load about four seconds, and if

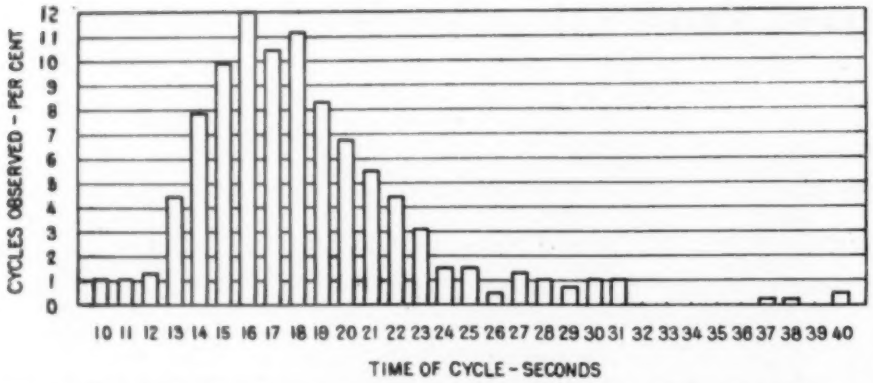


Fig. 1.—Diagram Showing Percentages of Shovel Cycles Performed in Various Time Intervals, Based on 383 Complete Cycles (4 Greater than 40 Seconds) of a ¾ yd. Shovel Working on an 8½ ft. Cut of Blasted Shale and Loading Trucks at Side. Average Time per Cycle, 18.9 Seconds

the shovel is of slow-swing speed it may be twice this amount. If the average time per dipper load is 20 seconds when loading at the side of the shovel, it will be somewhere between 24 and 28 seconds if the loading is at the rear. In other words, production will be cut from 180 dipper loads per hour to 150 or possibly as low as 128 per hour. Consequently, one of the essential requirements for high-shovel production is to so place the wagons or trucks that the swing of the shovel will be as short as possible.

For materials which clear the dipper freely the dumping time should not, in general, exceed an average of about one second, but sticky, adhesive materials require much skill on the part of the operator, if the average dumping time is to be held down to two or three seconds. A slow or inexperienced operator may readily consume two or three times as much time per dipper load. Daily production in very sticky or adhesive materials may therefore be as low as for poorly blasted rock.

The general tendency among highway grading contractors seems to be to do too little blasting as well as too little clearing and grubbing. It is not uncommon to find power shovels producing only about one-half the output which would have been possible had the blasting been well done. In materials which are too hard to dig readily without blasting, a good powder man is indispensable for satisfactory production.

In shallow cuts attention should be given to the time required to move the shovel forward. A modern crawler-type shovel in good condition can be moved forward in 15 seconds. If an average of 30 seconds is required, either the operator is slow or else the mechanism needs attention. The old-style wheel-traction type operating on mats will ordinarily require from five to seven times as long to move. This is a severe handicap where much shallow cutting is involved. In shallow cuts keeping the boom lower than normal and the shovel well forward will facilitate filling the dipper, while in deep cuts the boom should be kept high and the shovel well back from the face.

On the jogs studied an inadequate supply or poor operation of hauling equipment, or both, were the most frequent causes of slow-shovel operation in good common excavation. Trimming to grade and dressing slopes was the second most prolific cause for extending the time required per dipper load.

If the highest possible shovel production is to be secured, vehicles must be exchanged within the time required to handle one dipper load, or in good common from about 12 to 18 seconds. To operate the hauling equipment so as to meet this requirement is practical under ordinary field conditions, providing each vehicle can carry two or more dipper loads per load. It is not possible to so synchronize the operation of the hauling equipment that high production can be maintained consistently if only one dipperful is carried per load.

Number of Hauling Units Needed Requires Careful Consideration.—Since the shovel can, in general, only dig material when vehicles are in position to receive it the adequacy of the hauling equipment has a very decided effect on production. The number of hauling units of any given kind which are required varies almost directly as the length of haul which generally varies between rather wide limits and often at rapid, irregular rates. The characteristics which affect the rate at which the material can be dug by the shovel sometimes also change with unexpected frequency. In practice, therefore, it is found inadvisable to attempt to maintain an exact balance between the hauling equipment supplied and that just needed to maintain the highest rate of production at the shovel. Consequently, in many instances a definite number of hauling units is sent out and maintained on the job until it is completed. The result is that on very short hauls some of the equipment is idle or working at slow rate, while on the longer hauls not enough equipment is available to keep the shovel at a high rate of production. The question thus becomes one of determining what hauling equipment should be sent out in order to complete the job at the lowest possible cost.

Since it is general practice to maintain a fairly definite number of hauling units on the job, the utilization of the otherwise idle time on the short hauls therefore becomes a matter of considerable importance. At present, the general practice is to begin the fill at the nearest point of the cut, so that as the work proceeds the distance between the shovel and the dump continually increases. The result is that a large portion of the hauling equipment is idling when the cut is begun, but before the end is reached the shovel is waiting a considerable portion of the time. A better method which can frequently be employed is to begin the fill at the balance point or a sufficient distance away from the beginning of the cut, so that as the work proceeds the dump and the shovel will both progress in the same direction and with a haul sufficient to utilize the full equipment to the best advantage. Whenever possible the placing of fills should be so planned that the idle-time loss for the hauling

Conditions That Should Produce a Large Output: A Full Dipper Load of Easily Worked Material and a Short Swing

equipment will be reduced to a minimum. Surplus teams may often be used with fresnoes to do cleaning-up work usually done with the shovel.

Various types of hauling equipment are used with the power shovel, the most common of which are teams and bottom-dump wagons, motor trucks, and large tractor-drawn bottom-dump wagons. Teams are used more frequently than any other type, and in general, are very satisfactory for short to moderate hauls. The time required for turning, dumping, and maneuvering is relatively short and their average round-trip speed fairly constant at from about 220 to 240 ft. per minute over a wide range of road conditions. On jobs which have very wide variations in the lengths of haul, and especially if the longer hauls involve considerable quantities, the use of teams is apt to be uneconomical unless the conditions are such that either extra teams can be hired as needed or else that when the shorter hauls are reached the otherwise idle teams can be satisfactorily utilized on wheeler or fresno work.

Some of the difficulties of team hauling, especially for the longer hauls, would no doubt be reduced by a more general use of the 2-cu. yd. 3-horse wagons. Where team hauling is used the daily cost of remaining idle may readily reach one half the normal daily operating cost. Consequently, with a team outfit it is generally very important that work be carried on whenever it is at all practicable to do so.

Conclusions Reached Concerning Truck and Tractor Operation.—Heavy trucks, on the other hand, are apt to prove expensive on very short hauls. Three or 5-ton trucks are rather generally used in some sections. Where the prevailing hauls are moderate to long and the road, dump, and cut can be suitably maintained, these vehicles give good service. Trucks should be equipped with a quick-acting dumping mechanism which will raise the body to a high angle. Since operating room is restricted on most construction jobs, trucks with a short wheel base are generally found to turn faster both at the dump and the shovel—a very important matter on short-haul work where speed is of but minor importance. On long hauls speed becomes an extremely important element. Yet many jobs have been found where the road conditions were such that the average round-trip speed of the trucks was as low as 300 or 400 ft. per minute.

Except where the trucks were equipped with pneumatic tires no job has yet been found where trucks of this class could consistently maintain an average round-trip speed of over 8 miles an hour, or about 700 ft. a minute. Generally the speed has been below 6 miles an hour. Where heavy trucks are used more attention to road conditions would be profitable, as would the use of the dual-type pneumatic tires for the rear wheels. Whenever the turning time on short-haul work is long and the operating speed relatively low, the output of the truck can usually be considerably increased by backing the loaded vehicle to the dump and returning it forward to the shovel. Cases have been found where this method proved advantageous up to a haul of over 800 ft. On very short hauls the output of the truck can sometimes be almost doubled in this way.

Loading a Train of Tractor-Drawn Wagons

Bottom-dump wagons of 5 and 6 cu. yd. capacity drawn by crawler tractors have been found to be very efficient under a wide variety of conditions. Usually two of these wagons can be drawn by one good 10-ton crawler-type tractor. A good tractor operator can handle one of these trains effectively under conditions encountered in ordinary highway grading work. While the operating speed is rather low—about 275 to 325 ft. per minute—the dumping and turning time is low, so that two of these trains can ordinarily handle the full output of a ¾-yd. shovel up to a haul of from 600 to 800 ft. in good common excavation, and to a correspondingly greater distance in material which is more difficult to dig. Each additional train will extend the hauling distance by from 800 to 1,000 ft.

Where crawler tractors are used to draw large dump wagons, only skilled operators who will take an interest in the work should be employed. Since the number of tractor trains required for the economical operation of the ordinary highway grading job rarely exceeds three, it is very important that they be maintained in proper condition and operated with great regularity.

Power-shovel operation in highway grading work involves a large number of repetitive operations. The dipper must be loaded, swung, and spotted over the hauling unit, the load dumped, and the dipper then returned for another load. From time to time the shovel must be moved forward or maneuvered so as to keep it within easy digging reach of the material. The hauling units must be brought into position and loaded, the load hauled to the dump—at the dump turning and backing is often necessary. The load must then be dumped and the vehicle returned to the cut where turning and maneuvering is frequently necessary to get into position for receiving another load. As these operations are repeated over and over again throughout the day, it is clear that if a few seconds, or even a fraction of a second, are regularly lost on any one operation, the total loss during the course of the day will be large. If an operator working regularly on a 20-second cycle slows up only just enough to regularly add one second to each of the major operations of loading, swinging, dumping, and returning the dipper, the output will be cut from three to two and one half dippers per minute. Or, if the regular unhampered output is 90 wagonloads per hour, and the drivers of the hauling units slow down so as to delay the shovel only five seconds each time in getting into place to be located, then the output will be cut to 80 loads per hour.

Definite stops are, of course, obvious and every contractor makes more or less determined efforts to eliminate or reduce them. But a power-shovel outfit may operate all day without a single definite stop and yet not produce more than half the yardage it is capable of producing simply because the management is not aware of the effect on production of the constant loss of seconds or even fractions of seconds in the numerous repetitive operations.

Two Problems in City Paving

Extract from Paper Presented at 14th Annual Purdue Road School

By W. W. HORNER
Chief Engineer, Sewers and Streets, St. Louis, Mo.

In two respects, the city paving departments fail to measure up to the full expectation of the citizenship. The first of these is in the matter of surface smoothness and ease of riding on our newer streets. Most of us feel that we are doing a pretty fair job in this respect, but our country cousins, with all the advantages of highly organized mechanical equipment, are doing better, so that our city automobile owners returning from a pleasure drive outside, are filled with a mild discontent at the small jigging their wheels receive over some apparently smooth asphalt. However, little criticism may be justified, the demand for further smoothness is here, and it will be up to us to set aside our self-satisfaction with our present work and find means of further improvement. I have mentioned the disadvantage at which we are working on account of the absence of high grade mechanical equipment for the finishing of any of the types now in use on city streets. I think such equipment will be developed and that we can do a good deal to hasten this development if we continue to tighten up on our specifications for true pavement surface and on our efforts to see that specifications are carried out. The general adaptations of finishing machines to concrete streets does not seem to involve serious difficulties provided we once get over being satisfied with the inequalities of hand work and seriously demand something better.

In the laying of our block pavements, the use of running templates is already common, but in the case of asphaltic mixtures, we are still entirely dependent on the eye of the raker and the diligence of the roller man. I feel sure mechanical equipment for raking and levelling will be developed. I know that several agencies are studying the possibilities at this time. Only recently we have heard of a road contractor laying asphaltic concrete under a standard concrete finishing machine, but the perfection of equipment for mechanical raking and rolling will require much time and experiment, and more immediate improvement must be secured by forcing more intelligent workmanship through the pressure of more intensive and careful inspection and checking.

True Contour Concrete Foundations.—It has been hard to persuade either foreman or workman that a concrete foundation to be covered by an asphaltic mixture, has any need to be practically true in contour. If there is a defect, why not let the asphalt gang take care of it, and a lot of that has been done with the result that our asphaltic layers will often vary seventy per cent in thickness, and that rollers working on un-uniform thickness must necessarily leave great variations in density as well as unfortunate waves in the surface.

We are going to specify that our foundation concretes be finished to the ¼-in. limit heretofore given to surfaces, and if necessary to secure this we are going to check our concrete bases with string lines on five foot intervals before the concrete has set. This is going to be hard work for the inspectors and harder work for the engineers to keep the inspectors doing it, but it is a task that paving engineers must undertake and carry through if they expect their work to meet with the full measure of public approval.

Taking Streets Out of Service for Paving.—The other thing that makes a citizen dislike us, is our propensity to tearing up the street in front of his store or home and keeping it torn up for two or three months in order to lay a new pavement. I feel that we have been too prone to stand on our rights of taking streets out of service in order to carry out such public work. We have been too inclined to do this work in the way it has always been done and to carry out our paving programs in the way best suited to the type of organization that our contractors have customarily placed on the work. We have not understood completely what serious economic losses our street closing signs and barricades involve. Where we have a residence street under construction, the loss is perfectly definite and the annoyance is quite obvious, but when commercial and industrial thoroughfares are taken out of service the excess costs imposed upon the abutters and through them on the whole community, are very serious. In the larger cities, the realization of this situation has been growing for some years, and in the year past definite efforts have been made to introduce improved methods.

How a Paving Job Was Speeded Up.—As an example of this definite planning, there was carried out during the past summer in St. Louis, the repaving of Washington Avenue, a major thoroughfare running through the retail and jobbing districts, in which the work was all done in accordance with the scedule set out in the contract and specifications. This contract provided for the removal of an old wood block wearing surface, the greater part of an old concrete foundation, the laying of new concrete foundation, and a granite block surface with asphalt mastic filler. The contract laid down an ideal schedule which involved an elapsed time of four days from the disturbance of the old pavement to the laying of the new. On account of weather conditions and some slight labor trouble, this schedule was not lived up to in every detail but it was very nearly met. In the main, the high speed was accomplished by the introduction of night work, the requirment that concrete be mixed in a central plant and hauled into the work as fast as needed, specifications for a quick hardening cement, and finally a requirment of refinement of organization and supervision in every possible detail.

All of these innovations cost money, some of them not so much as might be expected, but in every single instance when the expected accomplishment was explained to the taxpayer and the expected increased cost figured up, the plan met with approval.

Use of Early Strength Cement.—In this particular project, the biggest item of time saving came from the use of the early strength cement. This cement, one of several of this type now on the market, gave strengths in two days equal to 28 day portland cement concrete. It costs less than $4.00 per barrel as compared with $2.00 for standard portland cement. With increased production of cement of this type, there is every reason to expect further reduction in price, but even at present prices the increased cost per barrel will not exceed $1.75, and the cost per square yard for 6 in. foundation will not increase more than 30 ct. This will amount to an average increased assessment of 75 ct. per front foot or $30.00 for the 40 ft. store building. For this increased cost, the saving of ten days in the time of curing concrete, is secured. There would be few merchants who would not tell you that their loss on account of street closure would not be in excess of $3.00 per day, and that they would gladly pay two or three times that amount to speed up a paving program.

With the full appreciation of what we are doing in the way of improved engineering and contracting to secure stronger pavements, pavements better adopted to modern traffic, and with every consideration of the necessity for economies in cost where ever possible. I feel that the biggest tasks before the city paving engineers today, are to secure pavements of more perfect riding quality, and to carry out our paving construction with the least possible disturbance to living conditions or to commercial activity. Our success in these two respects, is of the greatest possible importance in holding the continued support of the public to sound paving programs.

An Automobile Casualty Every 40 Seconds.—Every 40 seconds someone is either killed or seriously injured in an automobile accident. During 1927, approximately 26,618 persons were killed and 798,700 injured in these accidents, the American Road Builders' Association asserts.

Practical Application of Water Cement Ratio to Concrete Highway Pavement Construction

Results in New Hampshire Described in Paper Presented Feb. 21, Before Highway Section, Boston Society of Civil Engineers

By WALLACE F. PURRINGTON

Materials Engineer, New Hampshire State Highway Department, Concord, N. H.

THE purpose of this paper is to outline the practical application of the method of concrete design as applied to several highway pavement jobs, pointing out the various steps to carry this out and giving the results obtained.

This problem like many others is based on a premise. Our premise will be that the one most important condition pertaining to the production of concrete is the relation of water to cement. There are other factors entering into the manufacture of concrete which have a secondary bearing on our premise. These will be taken up in their proper order. The popular designation of our premise is the Water Ratio Law. This has been stated by the Portland Cement Association as follows:

"For given materials and conditions of manipulation, the strength of concrete is determined solely by the ratio of the volume of mixing water to the volume of cement as long as the mixture is plastic and workable."

The information to be covered in this paper will be based on observations made upon four highway pavement jobs which totaled 9.70 miles and contained 102,476 sq. yd. of concrete. Two of these jobs were built by the same contractor using similar equipment, while quite different apparatus, in part, was used by the other contractor.

Preliminary Inspection of Materials.—The preliminary inspection of materials is very important and the subsequent results are determined by the amount of work done at this time. Samples of the coarse and fine aggregates from the sources that are logical for the job are taken by some person from the laboratory. These should be carefully taken and should be representative of the quality and grading that could be supplied to the job. While it will be shown later that nearly any clean aggregates may be used in concrete, in our preliminary work we should use as great care as possible to choose the most economical material available. In general the most economical aggregates are those which, when designed for a definite strength, use the least cement and the smallest quantity of coarse aggregate to the cubic yard. At this point it would be well to explain that the term "strength" will be used quite often. The other desirable qualities of concrete are not lost sight of, however. It is just as important to have dense concrete as to have the material highly resistant to abrasion. Fortunately, the other desirable qualities are functions of strength when economy is considered. Using the proper amounts of aggregates in both cases, we would not expect concrete designed for 3,000 lb. per square inch to have the same degree of density or the same abrasion loss, as that concrete designed for 1,500 lb. per square inch.

When local materials are under consideration for use, the accurate determination of the proportions that are to be used before the crusher and screening plant is in operation is a little difficult. Experience has shown that it is not possible to determine these proportions approximately when the sizes of the revolving screens are known.

Testing of Materials.—The whole scheme that we are discussing presupposes that the materials are clean, structurally sound and of standard quality. To this end we test the cement, fine and coarse aggregate and in some cases the water. At present we are relying upon the modified Deval abrasion test to give us an idea of the acceptability of the stone or gravel.

Some one at some time conceived the idea that the measurement of the quality of sand for concrete could be carried out by the comparison of its strength tested in a certain way with a standard sand tested under the same conditions. We believe that this manner of testing is absolutely wrong and without foundation in theory or test. Just so long as the sand under test is coarser than the standard sand we should expect to get as high or higher results. This test penalizes a fine sand. Every engineer knows that there would be no objections to the use of a fine sand if it were used under the proper conditions. Probably there is no one subject that makes the engineer or user more skeptical of laboratory results than reports that he has occasionally received, relating to the quality of sands.

When you submit samples of sand to the laboratory for test you are anxious to know whether they are clean, structurally sound, and you should be also interested in their economy. You are not particularly interested in whether this sand meets the requirements of some arbitrarily standard sand. What you want to know is, will this sand make good concrete? In other words, will this sand either under test or on the job be strong enough to use. It is quite as possible to design the strength of a sand mortar as it is to design the strength of concrete.

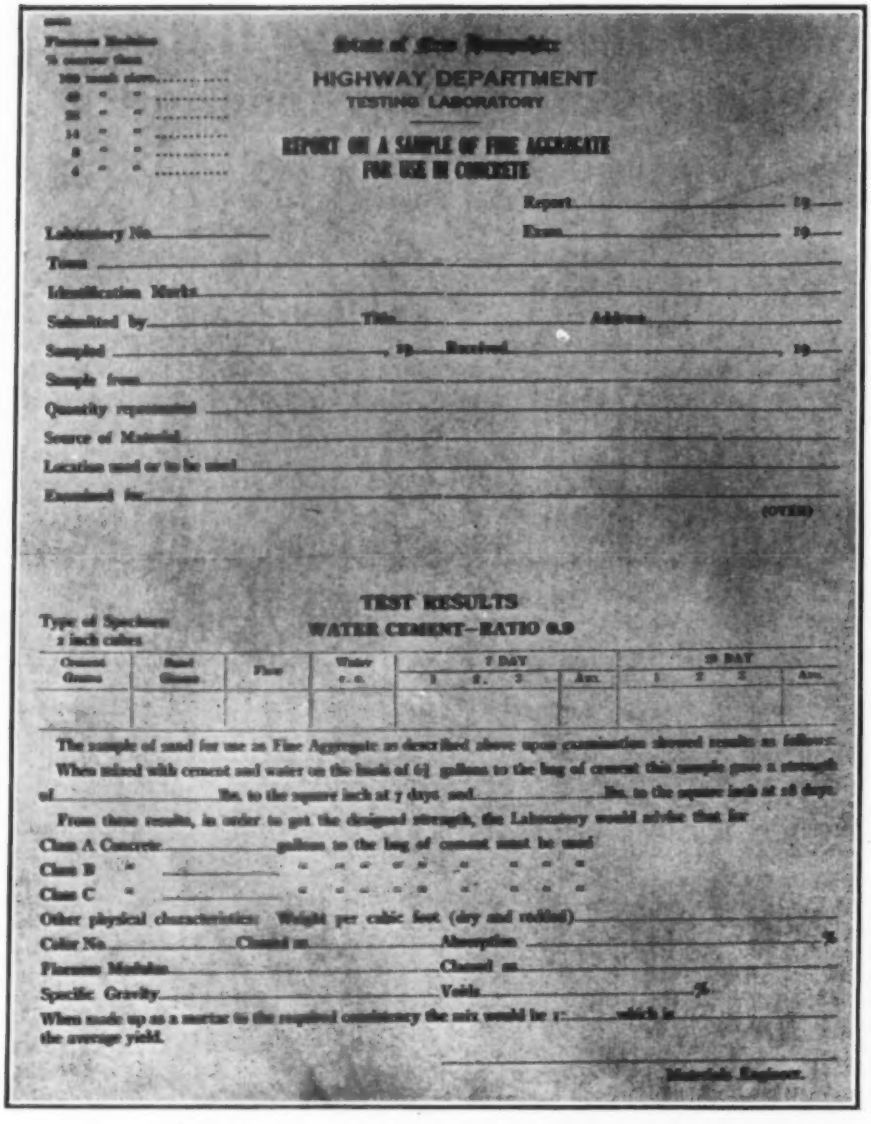
For nearly a year we have been making up mortar specimens of sand using a water-cement ratio of 0.90. We start with a certain amount of cement, to which is added the amount of water which will give this water-ratio. When this is thoroughly mixed, enough sand is added to give a flow of 200, using a flow-table designed by the Bureau of Public Roads. Two-inch cube molds are then filled and after storage in a damp atmosphere for 24 hours are stored in water for 6 and 27 days longer. At the end of this time these are broken. In order to be classed as a normal sand the cubes should not break at less than 1,800 lb. per square inch in 7 days, nor less than 3,000 lb. per square inch in 28 days. Sands showing a strength of less than these figures would be classed as weak.

On the basis of the sand being normal, we would advise the engineer that this sand would be satisfactory for use in concrete, allowing the use of 5½ gal. of water to the bag of cement. If the sand showed low strength we would advise that not over 5 gal. be used. By cutting down the allowance of water we would thereby cut down the yield. Under ordinary conditions this fact would discourage its use.

We take the position that under the proper conditions any clean, and we would emphasize the word clean, and structurally sound sand may be used in the manufacture of concrete.

Your reply to this would be in effect, that a weak or an extremely fine sand would not be economical. When you reply in this manner you are "beside the point." The primary function of a testing laboratory is to determine the quality of materials, not to study economics. When the quality of the material under observation has been determined, the laboratory might properly advise interested persons as to its economical use. We will show later that this advice has been to the mutual advantage of both the contractors and the state.

Design of the Mix by the Calculation Method.—The next step in our problem after the choice of materials



HIGHWAY DEPARTMENT
TESTING LABORATORY

REPORT ON A SAMPLE OF FINE AGGREGATE FOR USE IN CONCRETE

Report ..... 19..
Laboratory No. ..... Exam. ..... 19..
Town .....
Identification Marks .....
Submitted by ..... Title ..... Address .....
Sampled ..... 19.. Received ..... 19..
Sample from .....
Quantity represented .....
Source of Material .....
Location used or to be used .....
Examined for .....
(OVER)

TEST RESULTS
Type of Specimen 2 inch cubes
WATER CEMENT—RATIO 0.9

Cement Grams	Sand Grams	Fine	Water c. c.	7 DAY 1	7 DAY 2	7 DAY 3	7 DAY Ave.	28 DAY 1	28 DAY 2	28 DAY 3	28 DAY Ave.

The sample of sand for use as Fine Aggregate as described above upon examination showed results as follows:
When mixed with cement and water on the basis of 6½ gallons to the bag of cement this sample gave a strength of ..... lbs. to the square inch at 7 days and ..... lbs. to the square inch at 28 days.
From these results, in order to get the designed strength, the Laboratory would advise that for
Class A Concrete ..... gallons to the bag of cement must be used
Class B " ..... " " " " " " " "
Class C " ..... " " " " " " " "
Other physical characteristics: Weight per cubic foot (dry and rodded) .....
Color No. ..... Cleaned on ..... Absorption ..... %
Fineness Modulus ..... Cleaned on .....
Specific Gravity ..... Voids ..... %
When made up as a mortar to the required consistency the mix would be 1: ..... which is ..... the average yield.

Materials Engineer.

Fig. 1.—Form Used for Report on Sample of Fine Aggregate for Use in Concrete

has been made, is to take these materials and combine them with cement in the most economical way. There are two schemes by which this can be done. These are termed, the Trial and Calculation Methods. There is no great advantage to the state in letting the contractor use the trial method on a job that calls for a large quantity of concrete. Carrying out this method a contractor is told the amount of water that can be used to a bag of cement and then he manipulates his aggregates by trial, in such a way that he gets the most workable mix. This does not necessarily give the most economical combinations of material. If the water ratio scheme was dependent upon this, in all probability neither the contractor nor the state would be satisfied with the results obtained.

We determine all of our mix proportions by the calculation method. This method and all the steps involved are clearly explained in the 1927 edition, "Design and Control of Concrete Mixes," published by the Portland Cement Association. The mathematics involved is very simple, a set of scales, screens and containers for determining the weight per cubic foot is all the equipment necessary.

Let us now take up the steps that are necessary to design a mix of concrete for use in a highway pavement job in New Hampshire. We state in our specifications that the contractor shall not use more than 5½ gal. of water (including the water in the aggregate) to each bag of cement (assuming the cement to weigh 94 lb.). This is a fixed value and cannot be changed. On a pavement job at the best the proportioning will never be carried on as accurately as in the laboratory so we refer to the well known Abram's Curve and find that 5½ gal. of water hits the B Curve at about 2,700 lb. This then becomes our basis of design. We don't want too sloppy a mix, neither do we want it to be too dry, therefore we decide that a mix which will give a slump of from 3 to 4 in. will produce the right workability. We have now determined the consistency that we are aiming for.

When we mix cement and water together we form a mineral glue. We now want to use this glue to coat the sand and stone particles and cement them together. If we used all sand particles we would find that our glue would not go very far. If we used all stone particles we would find that our glue would go far enough but that we would have too high a percentage of voids and we would lose the desirable quality of density. By the use of more sand and less stone we finally come to a place where we get the mix which will give the densest, most economical and strongest concrete for the given conditions. It is not the purpose in this paper to give all the details of the method of calculation, only repeating the statement that this is easily available to interested parties.

We report to the contractor the mix proportions on the dry and rodded as well as on the field basis. On the dry and rodded basis is determined the barrels of cement and the quantities of aggregates necessary for a cubic yard of concrete. When the actual operation of mixing commences the contractor is interested in the quantity of materials he will have to use under the conditions prevailing at the time. As all our contractors proportion by volume, it is necessary to determine the percentage of moisture and the weight of the material per cubic foot in the damp and loose condition. The bulking factor is taken account of in our design.

At this point we have worked up the preliminary data and are now ready to furnish the information to the contractor.

Selling the Idea to the Contractor.—Our department takes the position that a close cooperation between its engineers and the contractor will eventually be reflected in lower prices for projects. To this end, for this type of work, it places at the disposal of any contractor the facilities of its laboratory, both preceding and during the progress of the job. This fact is definitely written into the specifications.

The contractor's first reaction to this offer may be skepticism. There may be two definite reasons, based possibly on past experiences, for his unfavorable attitude. He might be suspicious that some one was trying to "put something over on him" or that the laboratory was too theoretical.

We are perfectly safe in saying that our state highway commissioner would never have approved nor adopted the Water-Cement Ratio Method unless he felt that quality concrete could be produced at lower cost. Neither would we

have tolerated the carrying on of experiments which would have resulted in increased costs or hindrance to the contractor.

Assuming then, that the interests of the contractor and the state are identical, in that they both want a good job done, and that they both wish this job carried on with the least expenditure of money, they are both in a position to establish cordial business relations.

We will cite an incident as to how this actually worked out. A certain large contractor before bidding on a good sized concrete pavement job came to the conclusion that it would be good business to avail himself of the information that he was told could be had from the laboratory. He asked for and was given the mix that could be used on the job, using the materials from a source designated by himself. On the basis of the figures submitted, he bid and was awarded the contract. The job is nearly completed and it has been quite possible to carry on this project without any practical difference in proportions from those furnished originally. This contractor was no theorist, but a farsighted business man out to make the job pay. There were two things that he might have done viz., worked out his mix by the trial method or carried out the calculation of the mix by members of his own organization. We do not insist that our figures be used. There is one thing and one thing only that we do insist upon and that is that he uses no more water than he is allowed and that the resulting concrete be plastic and workable. One of our bid problems, at first, was to convince the contractor that the Water-Cement Ratio Method was workable. This called for salesmanship. Later in this paper we will give the contractor's answer as to whether or not we were good salesmen.

Starting and Controlling the Job.—Just before the contractor is ready to start casting, the laboratory with the field inspection force check the measuring devices used for the measurement of water and aggregates. The moisture in the aggregates is then determined. The quantity of water in the batch, using the laboratory figures, is subtracted from the 5½ gal. which is allowed. If a calcium chloride solution is used, it will have to be deducted as well. We then go to the mixer and set the water regulator for the required amount that must be added. It is necessary to have the mixer on as level ground as practicable. If the mix is properly designed and the designed quantities are carefully measured out with the required amount of water, concrete of approximately the desired consistency as indicated by the slump test may be expected. Slight differences in the resulting slump from those desired can be rectified by slight changes in the proportions.

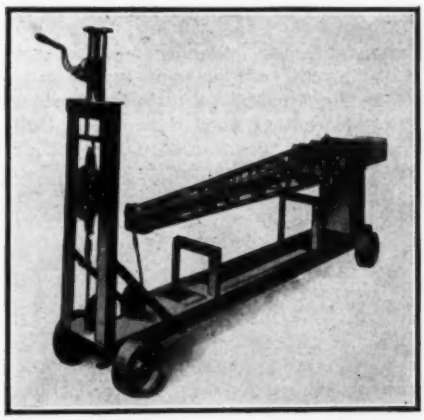


Fig. 2.—Type of Beam Testing Apparatus Used by New Hampshire Highway Department

The following statement which he will make can be proved by statements from two inspectors, the superintendent, the foreman of the mixing gang and the mixer man.

Not once during the laying of three miles of a concrete road job was the water changed and only once was it necessary to change the quantity of aggregates, and this was due to the fact that the grading of the aggregates was different. We wish to emphasize the above statement for we have heard it stated many times that it was impossible to carry on a job and do this.

He will also state that this job was laid on very level land. On another job laid by the same contractor, he was able to build two miles of road without changing the mix from that furnished originally by the laboratory. This was a hilly job. Here we kept the mix and the slump constant. Owing to the mechanical construction of the water delivery system we were obliged to change the reading on the water gauge when going up and down a grade. While there was an apparent difference as far as this gauge was concerned, actually there was the same amount of water delivered in each case.

No change of the amount of aggregates was made on still another job, built by a wholly different contractor, but we changed the reading on the gauge once due to a very stiff grade. We also found that the ordinary rainstorm did not affect the amount of water in a stockpile to any great extent. Should a heavy rainfall occur, we would have no objections to allowing the mixer man to cut down his water for a short time until moisture conditions came back to normal. Our inspectors would see that the mix was not changed and the same degree of workability was maintained. All three of these jobs were built of imported, washed aggregates. It is our experience that concrete roads should be built of nothing but washed sand and gravel or clean crushed rock. Such a recommendation has been made to our commissioner for all future work. The extra cost for washed material is small, but results in quality and economy of the finished product are great. When an unwashed material is used it is almost impossible to maintain uniformity of product as well as to keep it free from dirt.

Inspection.—Without the enthusiasm and interest of our inspection force the carrying out of the method would have been difficult. Each member of this force was definitely told what was to be accomplished and the manner in which it was to be done. We tried to convey the idea to him that we had simply set up the laboratory for the time being in the field and that the job was a laboratory experiment in which he was a vital part. It was not long before the contractor's representatives caught the spirit of the idea and throughout the various projects even the ordinary laborer wielding a shovel took pride in helping produce the results that were obtained.

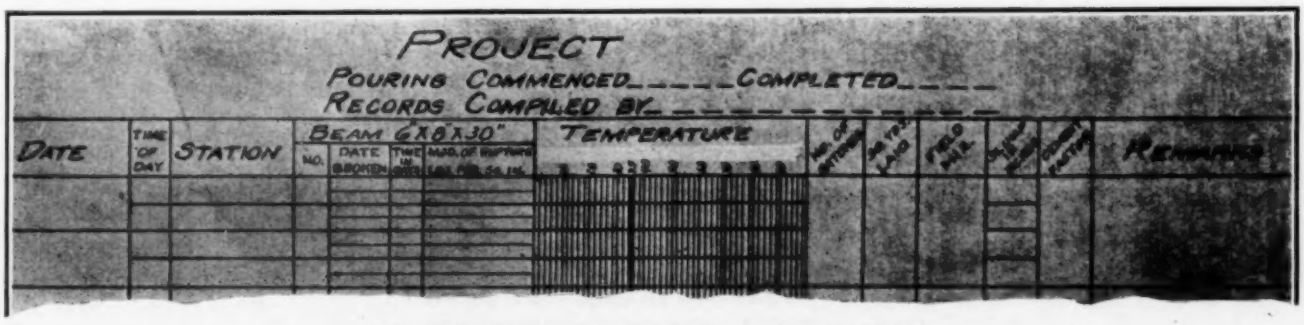

PROJECT
POURING COMMENCED_____COMPLETED_____
RECORDS COMPILED BY_____
DATE | TIME OF DAY | STATION | BEAM 6"x6"x30" NO. | DATE BROKEN | TIME IN MIXER | MOD. OF RUPTURE | TEMPERATURE | NO. OF BATCHES | SLUMP LAID | FIELD MOIS. | SLUMP USED | CONCRETE TEMP. | REMARKS

Fig. 3.—Headings of Form Used for Keeping Records of a Job

During the progress of the work we cast beams from the mix after it had been deposited on the ground. From five to seven days later part of each beam was tested. When the beams showed a modulus of rupture of 350 lb. or over to the square inch, the contractor was notified that he might have the road for his own use. This not only expedited the work but made a definite saving of money to the contractor. We cast beams also which were broken at the end of 28 days. After these beams were removed from the molds, they received the same treatment that was given the pavement. Considerably higher results might have been shown if these beams could have been immediately stored in a damp closet under standard storage conditions. We were more interested in what strength developed under actual conditions than we were in the strength that might develop in an artificial manner. From the same lot of concrete slump, tests were carried out in order to check the workable conditions of the mix. On these jobs a uniform system of records were kept. On one of these projects a maximum and minimum thermometer was used in order that temperature might be recorded. It is a well known fact that the early strength of concrete is considerably affected by temperature conditions especially during the first 24 hours. During 1928 we expect to cast concrete beams using a mix similar to what would be made on one of our projects. Part of these beams will be stored under standard conditions while the other part will be kept out doors. We shall carry out this work during the spring and the summer. We expect by this study to learn something from the cooling effects of the spring nights and the heat of the midsummer's sun on a concrete mixture. If this study is successful it may be possible to correct for temperature in order to report results based on standard conditions.

Project	Mileage	Compression Designed 28 days, lb.	Compression Obtained, lb.	Modulus Rupture 28 days	Cement Designed	Factor Obtained
Dublin	1.77	2,700	3,135	570	1.45	1.51
Dover	5.03	2,700	2,810	511	1.40	1.43
Claremont	2.01	2,700	3,000	551	1.45	1.49
Lebanon	0.85	.....	.....	.....	1.42	1.47

Results Obtained.—"A man is measured by his works." This might be paraphrased to cover the problem that we are discussing as follows: The theory sounds fine but what about the results. In other words can the same kind of concrete be made under field conditions in wholesale quantities, that a laboratory worker can put together in a small way. All highway pavement concrete in New Hampshire is designed to give a strength after 28 days of 2,700 lb. to the square inch. We do not expect to get as a result concrete much stronger than this. If we wanted stronger concrete it would be a simple matter to bring it about through our design.

At the time of bidding, the cement factor that should be applicable to the job is furnished the contractor. Each day this is figured, based on the amount of concrete placed and on the number of bags of cement used. At the end of the job the average factor is calculated. The following tabulation of results has been obtained from three jobs where accurate records have been kept. The cement factor on another job is given.

From these figures it would appear that the greatest variation in the quantity of cement used was on the Dublin project and this was only 0.06 bbl. The fact should be appreciated that our design was based on a theoretically perfect subgrade which would use neither more nor less than 35.2 cu. yd. of concrete to each 100 ft. of 18 ft. of road. Also these figures do not allow for wastage. On the Lebanon job there was a difference in the amount of cement used on each half of the job of only 20 bags. As was mentioned before, we feel that we do not know yet all that can be learned on the subject, and therefore, we may be able to lower the difference between the designed and the obtained cement factor figures.

So much for the contractor. It is now time to look at the results which have accrued to the state. The benefits to the state can only come in maintaining the quality desired and at the same time save money. Reference to the above tabulations will show that we were furnished with a satisfactory grade of concrete. We did not receive 4,000 pound concrete, neither did we ask or pay for it. It is quite true that cement prices are somewhat lower this year than last, but at the most this difference would not lower the price of a square yard of concrete more than three cents. The following is the comparative data for costs of concrete for 1926 and 1927, as built under the supervision of the New Hampshire State Highway Department.

1926

	Sq. Yd.	Unit Price	Total
Landaff	3,000	$2.75	$ 8,150.00
Manchester	10,400	2.65	27,560.00
Exeter	14,334	2.74	39,285.16
	27,734		$ 74,995.16

Average price per square yard $2.74

1927

	Sq. Yd.	Unit Price	Total
Dover	53,096	$2.15	$114,156.40
Salem	13,600	2.25	30,600.00
Lebanon	8,998	2.44	21,955.12
Claremont	21,738	2.45	53,258.10
Lisbon	4,012	2.36	9,468.32
Dublin	18,644	2.55	47,542.20
Tamworth	18,556	2.23	41,379.88
Bedford	13,291	2.25	29,904.75
	151,935		$348,264.77

Average price per square yard $2.291

If 1927 contracts were let at 1926 prices, the additional cost to the state would have been $68,150. This is a saving of $4,729 a mile.

Opinions of Interested Parties.—Earlier in this paper we mentioned the fact that part of our problem called for salesmanship. There would not be a great deal of profit accruing to the state in the adoption of the method under discussion unless the contractor used information which was available to him preceding the opening of bids. We want him to use as low a cement factor as is consistent under the conditions and have the lower cost of cement reflected in his bid. To this end our department encourages its laboratory to furnish the contractor with any information relative to economical mixes which he may request.

Recently we sent out a questionnaire to one of our leading contractors. This questionnaire in its exact words and the answers are given below. This contractor stands very high in the road building industry. These answers are not written to flatter; but represent facts.

Contractor's Questionnaire

Question. What was your opinion of the Water-cement Method of control before trial?

Answer. Rather skeptical.

Question. What is your present opinion and why?

Answer. We are in favor of this method because we are able to get a better working mix, and it also saves us money on the amount of cement used.

Question. Did you know that before bidding the job the laboratory facilities of the state highway department were at your disposal to furnish the theoretical quantities of material that might be advantageously used by you in the manufacture of concrete on the job?

Answer. Yes.

Question. Did you take advantage of these facilities?

Answer. Yes.

Question. The average cement factor for your two jobs as computed by use were as follows:

Job	Designed Factor, bbls.	Factor used (ave.), bbls.
Dover-Somersworth	1.30-1.40	1.43
Dublin	1.45	1.51

From your experience, is this difference any greater than with an arbitrary mix?

Answer. No special difference from arbitrary mix, but any difference would be from the grading of the aggregate which seems to control the amount of cement used.

Question. There are two men in your organization who probably come in contact with concrete operations more closely than do you yourself, viz., the superintendent and the foreman at the mixer. What is the opinion of the superintendent, of this method?

Answer. The superintendent agrees with the above statements.

Question. What is the foreman's opinion?

Answer. None.

Question. The New Hampshire specifications allow the use of coarse aggregate up to 3 in. but contractors are not using aggregate larger than 2½ in.

It might be possible to design a mix reducing the quantity of cement without impairing the quality of concrete by using a little larger aggregate. Is this idea feasible?

Answer. Yes, but the amount of stone larger than 2½ in. would have to be carefully regulated so as not to affect the finishing. There would surely be the tendency to put in more of the large stone, especially if coming from a commercial plant.

Question. From the contractor's viewpoint please give any criticism of last year's work as it applies to this problem. We would gladly receive any suggestions that you might offer for the future.

Answer. We feel that it is impossible to have a set formula for concrete road work and do feel by your method of having a certain amount of cement and water but varying the proportions of the aggregate, you get a strong concrete and save us money, and this also is reflected in the prices that are bid for the work which saves the state money.

With this testimony we will rest our case.

Conclusion.—The study that we have given to the manufacture of concrete this year has been very interesting. It has convinced us that the Water-Cement ratio Method is sound in principle and practicable to apply on the job. It has created a very fine spirit of cooperation between the contractor and the representatives of the state. It has given us quality concrete at a reduced cost. This lowered cost has made it possible to extend the building of this very fine type of pavement in our state.

A. B. Fletcher

Austin Bradstreet Fletcher one of the country's foremost highway engineers, died of pneumonia at 3 p. m., March 8, at his home, 24 Hesketh St., Chevy Chase, Md. He had been ill only a week. While on a business trip he contracted a cold at Cleveland, O., which upon his return to Washington grew steadily worse and finally developed into acute pneumonia.

Mr. Fletcher was widely known and respected as a leader in the field of highway engineering. As state highway engineer of California, from 1909 to 1919, he rendered conspicuous service in the formulation and direction of the program of modern road improvement in that state.

With the creation of the California Department of Public Works in 1919, Mr. Fletcher became the director of public works, a position which he held until 1923 and in which he was in charge of all engineering works of the state.

In the summer of 1923 he served as consulting engineer for the New England Rail Committee, a body made up of representatives of the six New England States, and charged with the duty of studying the entire transportation situation in New England. Mr. Fletcher was called upon to make a special study and report of highway transportation conditions.

Since July, 1924, he has served as consulting highway engineer for the United States Bureau of Public Roads, continuing in this connection his valuable services to the cause of road improvement in the United States.

A. B. Fletcher

Mr. Fletcher was born at Cambridge, Mass., Jan. 19, 1872. He was a graduate of the Lawrence Scientific School of Harvard University, from which he received an S. B. degree in 1893. For several years after his graduation he was the Secretary and Executive Officer of the Massachusetts Highway Commission, one of the earliest of the State highway departments. In the summer of 1916 he was selected by the Secretary of Agriculture to assist in drafting rules and regulations for carrying into effect the Federal aid road act, passed by Congress in that year. He was a member of the American Society of Civil Engineers, the American Society for Testing Materials, the Boston Society of Civil Engineers, the American Association of State Highway Officials, the Association Internationale Permanente des Congres de la Rout, and various other engineering societies, a fellow of the American Geographical Society, a member of the Massachusetts Society of Sons of the American Revolution and of the Society of Colonial Wars, California. He was also a member of the Cosmos Club, Washington, D. C., the Harvard Club of San Francisco, and the Harvard Engineers Club of New York City.

He is survived by his wife Ethel and one daughter, Mrs. Lawrence H. Chapman of Sacramento, California.

Experimental Bituminous-Treated Earth Road in South Carolina

An experimental road has been constructed in South Carolina during the past year which, it is hoped, will result in the development of a satisfactory method of bituminous treatment of the loosely bonded sand-clay roads characteristic of the southeast coastal section of the country. This experiment is being conducted by the United States Bureau of Public Roads in cooperation with the South Carolina State Highway Department. The test road extends from Conway to Galivants Ferry, a distance of 21 miles. It is on an arterial highway and carries relatively heavy traffic during the spring and summer months.

The sand-clay soil with which this road is surfaced possesses little natural binder and is composed for the most part of fine-grained sand particles. As a result, the surface breaks down and becomes exceedingly dusty in dry weather, and when wet it cuts up rapidly and becomes almost impassable. The unstable nature of the road surfaces in this region precluded the use of the ordinary type of bituminous surface treatment, and it was decided, therefore, to investigate various types of bituminous mixed-in-place treatments.

Construction by the mixed-in-place method consisted of scarifying, shaping and pulverizing the road surface, after which the bituminous material was applied in several applications by pressure distributors. The surface was disked lightly after each application. This proved valuable in preventing loss of the lighter constituents of the bituminous material. Mixing was done with a blade grader, the procedure being to carry the treated material from one side of the road to the other until a uniform mixture was secured. Then the material was spread, shaped and allowed to compact under traffic. For those sections built to receive machine maintenance this completed the construction. The sections which were to receive a surface treatment were allowed to set up and harden for a week or ten days, after which they were given a single or a double surface-treatment.

Detailed records will be kept regarding the maintenance costs and service of the different sections so that the comparative value of the various treatments may be determined.

The Auto-Strade (Automobile Toll Highways) of Italy

Nearly 500 Miles of Motor Roads Now Built or Proposed

By FRANCIS MILTOUN

SOON after Signor Piero Puricelli, highway engineer, built the famous autodrome at Monza just north of Milan he became impressed with the idea that what Italy needed was a new roads system. His perspicacity and the ingeniousness of his presentation of his scheme enlisted the sympathy and aid of Benito Mussolini, president of the Italian ministerial council. From this effort, conceived and actually brought into being in the last three years, Italy has become endowed with nearly 500 miles of concrete motor highway, either completed and in operation, under construction or under survey. And this is only the beginning.

Puricelli had seen what a drawback to prosperity the bad roads of the Lombard plain actually were and it was easy for a competent engineer to work out a scheme on paper which would only lack the means of its practical application to be something which should bring prosperity to a region only too badly served by the existing roads system and indeed that of the railway lines themselves. Thus was brought into being the first 60 odd miles of the Milan-Italian Lakes Auto-Strade which was to set the pace for that which was to come after.

Already for two years three spurs from Milan, the industrial capital of the north to the lake region have been in operation and paying a profit to the concessionaires out of the tolls which are imposed upon users as regulated by law.

Recently another section of nearly a like length has been inaugurated under the auspicious presence of Mussolini, himself, as was the case in the first instance. The new spur runs from Milan to Bergamo, northeast through the Lombard plain, ultimately to be continued to Venice and the eastern frontier, which latter portion is already under survey.

There also has been built a short length linking Rome with the ancient port of Ostia which the "Romans of Rome" expect to develop into an aristocratic watering place and another from Naples to Salerno. There is also the project well in hand to carry the strada from Milan west to Turin and into the foothills of the Alps, south to Genoa and westward again to the French frontier at Ventimiglia.

The distinction which applies to the construction of these various units is that each is financed and developed independently of the other. The Milan-Lakes section is distinctly a Milanese affair, that of Milan-Bergamo a Bergamese enterprise, Turin in its turn, Genoa in its. The bond issues may have a wider distribution than that of a mere local enterprise but the prime idea is that a region or community which really wants to get in step must finance its own project, at least organize it.

The principal plank of the platform upon which the idea was built which so captivated Mussolini's farsightedness was born of the brain of Signor Puricelli: "An auto-strade may logically be built only in a district where there is a present, or potenial, traffic to support it, not merely to replace a bad road which though it may be a disgracious thing in itself could be made sufficient for the minor claims likely to be put upon it." This was the text which sold the idea.

These Italian auto-strade are necessarily toll roads, the state not being in a financial condition to permit of the remaking of a whole new national system of trunk line highways. There is perhaps a little psychology therein also. The public might after all object, even in a country of a dictatorship, that one class of roads—those intended solely for motor traction—be developed out of public resources whilst appealing to only one class of road user. This is perhaps by the mark, perhaps not; the Italians are a very perspicuous people and often carry their reasoning to an extreme limit, in this case the extreme is logical.

The considerations entering into the design of these toll roads are set forth in the annual report of the Milano-Laghi section; they apply, of course, to the other units:

Virtual straightaway roads with such existing bends and curves as may be necessary of a wide radius of approach. This obviates the danger element for fast traffic and likewise the necessity of slowing down which is normally a constant speed traffic. On the Milan-Lakes section there are various straights of from 8 to 18 kilometers and one of virtually 24 kilometers on the Milan-Bergamo trunk.

Width should be such as to carry the prospective traffic load without crowding. The average is 14 meters, easily carrying four vehicles of whatever ordinary bulk abreast.

Surfacing should be of a material having an absolute homogeneity. In this case cement on a concrete foundation.

Total suppression of level crossings, as well for the railway as for highways.

Possibility of avoiding passing through closely built agglomerations.

Signor Mussolini, authorized the constituting of the Sociata Anonima Autostrade per la Construzion e l'Exercizio della Rete Tradale per Autoveicoli Milano-Laghi-Lombardi.

The exclusive proprietorship in these roadways belongs to the concessionaire for a period not to exceed 50 years when they are to revert to the State.

The first stretches brought about the expropriation of 3,000 properties at a cost exceeding six million lire ($315,000). Actually the terrain through which the road passed is very variable as to composition, running from marshy ground to the rocky escarpment of the higher elevation of the foothills of the Alps as it runs farther north. The tourbe, or peat beds, of the Lombard plain gave no little difficulty necessitating the consolidating of the foundations with a gravel base.

Various overhead and underpass bridges in reinforced concrete were constructed for the avoidance of level crossings. In almost every instance these bridges are what Europe calls an ouvrage d'art—a work of art.

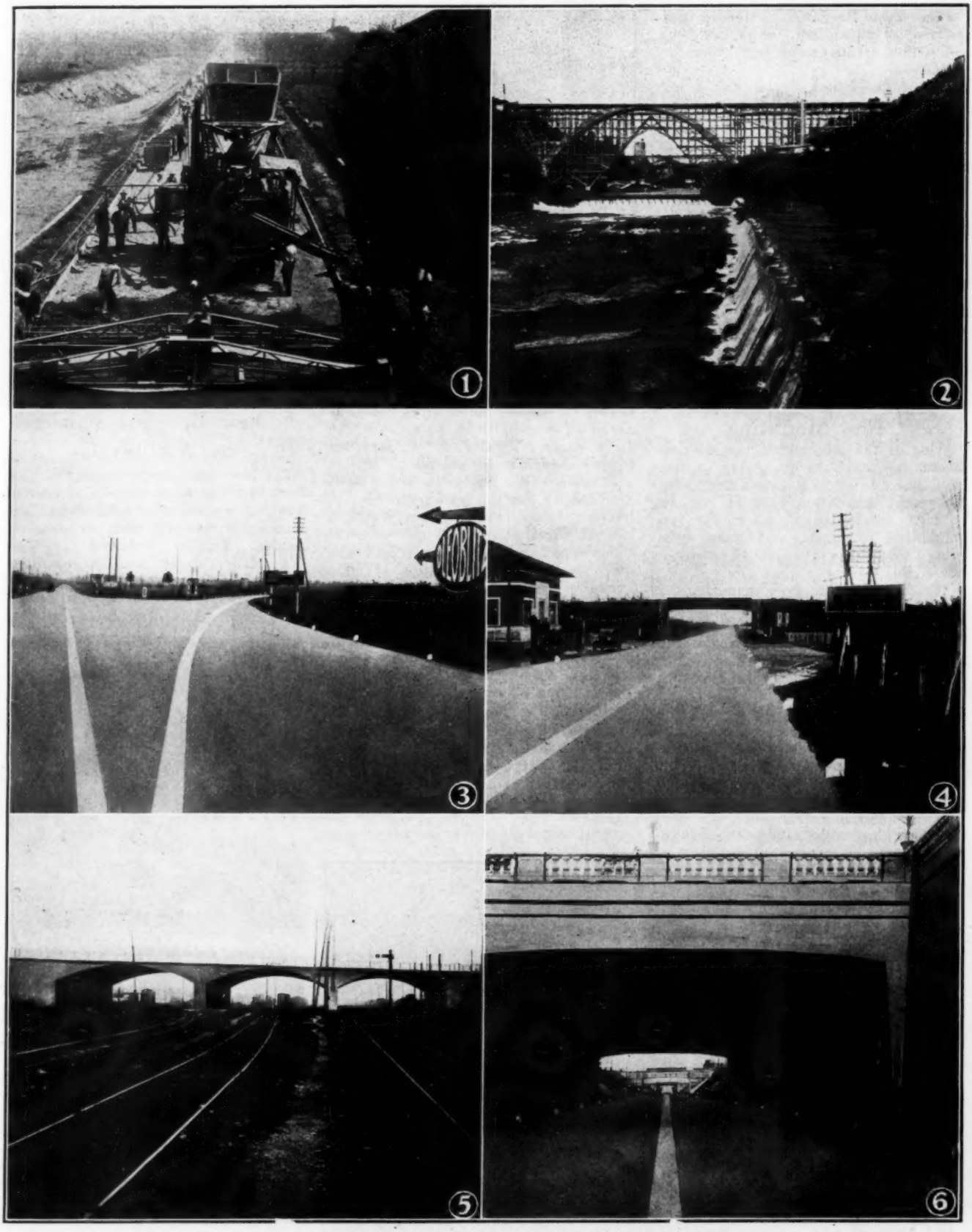
Above four thousand laborers were employed at one time.

Roadside gasoline stations have been erected at various points on the strada which for the most part has a width of 14 metres. The toll, or gate houses at either end serve also as rest houses for travellers with the usual first aid accessories, telephonic communication, etc., and also for the supply of gasoline and oil.

Heavy duty vehicles on pneumatic tires may not exceed 40 kilometers an hour or if on solid tires, 20 kilometers an hour. Tourist cars may make what speed they may.

The toll charges work out approximately the equivalent of $1.50 for the Milan-Como and the Milan-Bergamo run for the average car, with concessions and rebates for quarterly and yearly season tickets, the latter approximately $60 and $90.

The Milan-Lakes section is capitalized at 50 million lire ($2,625,000), bonded at 5 per cent. On reversion to the state any unliquidated balance will be paid by the state for bonds which



Views of Various Sections of The Automobile Toll Highways of Italy

(1) American Road Building Machinery at Work on the Milan-Bergamo Section (Note the Elevated Water Feed Pipe to Mixer by Means of Which the Hose Is Kept Outside the Forms). (2) Reinforced Concrete Bridge Under Construction on Milan-Bergamo Section. (3) Bifurcation on Milan-Italian Lakes Section. (4) Toll House at Varese Entrance to Milan Auto-Strade (Note the White Markers for Keeping Traffic Off the Shoulders). (5) Bridge Carrying Milan-Sesto Calende Section over Railway. (6) How a Crossroad Is Carried over the Milan-Como Section

may not have been retired up to that time.

The Milan-Bergamo section is capitalized for 20 million lire ($1,050,000), on a like arrangement for reimbursement.

The Milan-Lakes section has a balance sheet of expenses and receipts for yearly operation as follows:

Expenses	
General operating expense	$157,500
Interest and amortization charges	78,750
	$236,250
Receipts	
Tolls	$367,500
Various concessions (supplies, publicity, etc.)	52,500
	$420,000
Net profits per annum	$183,750

It is believed that the newly opened Milan-Bergamo link will show an even more favorable operating schedule by reason of its serving a more intensively industrial region.

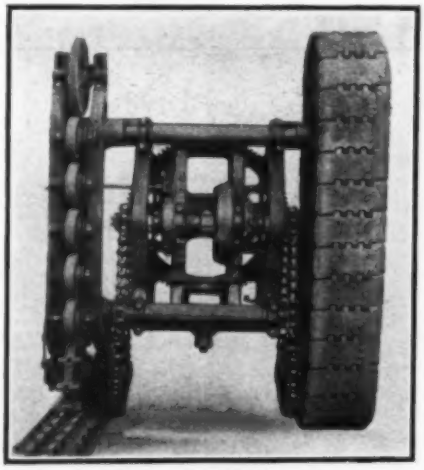
Bucyrus-Erie Shovels Have New Mounting

One of the interesting new developments in excavating machinery for road building and general contracting noted in recent convention exhibits, was the "Single Shaft Drive" caterpillar type mounting for Shovels and Cranes introduced by the Bucyrus-Erie Company, of Erie, Pa.

Since caterpillar type mounting has come to be recognized generally as the most satisfactory for power shovels and cranes, the most important consideration now is to get the continuous-tread mounting in its simplest and most reliable form.

As the new Bucyrus-Erie mounting has fewer parts, extra strength can be built in with no added weight. Besides which, this new mounting combines several unique features that users are finding very valuable in service, according to the manufacturers.

The "Single Shaft Drive" mounting



View of the New Mounting, Showing Its Simplicity

is in the highest degree non-clogging—even when it is shoveled full of dirt, it throws out the material as it moves ahead its own length, it is claimed. The drive chains, which are of hardened forged steel are self-cleaning.

It easily takes grades of 30 per cent, and steeper, say the manufacturers. A two-way brake, which operates with a ratchet effect, allows free movement in either direction as desired, but locks the machine against the digging, or on a grade.

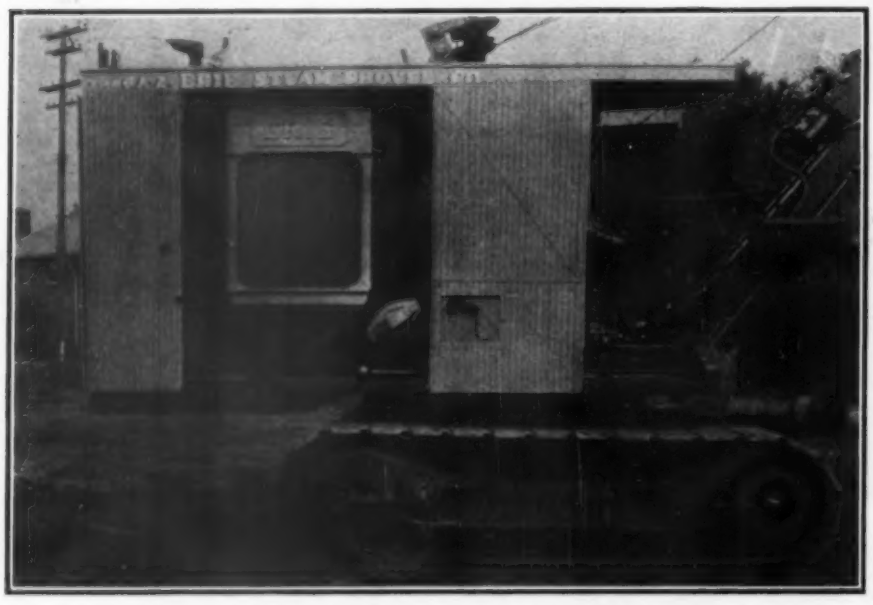
Sharp turns can be made with this mounting as well as gradual turns. It can make either a right angle turn in one spot, or a long radius turn—steering from either end of the treads, with the machine moving either forward or backward, it is said.

Another feature of this mounting is its perfect accessibility for renewing or inspecting parts. Any wearing part of this mounting can be quickly and easily removed without disturbing any other part.

With only one drive shaft and gear below the deck, the extreme simplicity is very noticeable. The one gear and its pinion are enclosed, protected against dirt and grit—and operate high above the ground. There is 12-inch clearance underneath; nothing to drag when moving over rough uneven ground.

The truckframe is a one-piece annealed steel casting, 23 inches deep—practically indestructible. Drive shaft splined—no keys. Treads are exceptionally strong, and have 1½ in. hardened steel pins.

All Gas+Air and B-2 Steam Bucyrus-Erie machines are now being furnished with this new mounting as standard equipment. Its simplicity and strength, combined with its performance on many machines which have seen hard service, has shown it to be a meritorious mounting for shovel and crane work, say the manufacturers.

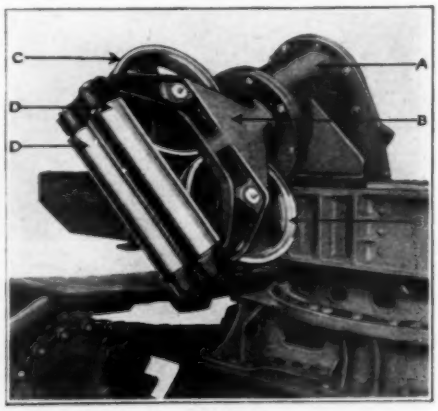


A Bucyrus-Erie Machine Equipped with the New Simple Mounting

A New Dragline Fairlead by Northwest!

The Northwest Engineering Co., Chicago, builders of gasoline and electric shovels, cranes and draglines, announces a new fairlead for dragline service. This is designed for their Type M, Models 104 and 105 machines.

The chief feature claimed for this lies in the great reduction of wear on the drag cable. The drag cable can lead



New Northwest Dragline Fairlead

to either side of the machine to an angle of 75 deg. and not rub or scrape in any way on anything. It is in contact with but one sheave at a time and the sheaves being large there is a minimum amount of bending.

It consists of (A) a rigid steel housing bolted to the rotating base casting. This is bored to receive two races of roller bearings in which turn the rotating portion (B). Section (B) carries to sheaves C-C and to roller D-D. The drag cable passes between D-D, C-C, and through (B) and (A), which are hollow to receive it. As the angle of the cable swings the fairlead rotates to suit. The rollers D-D take the momentary sideways push and the sheaves guide the final pull.

The Personnel of a Highway Maintenance Organization

Paper Presented at 1928 Highway Engineering Conference at University of Michigan

By S. J. STEWART

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ALL experienced men realize the importance of good organization in any line of human endeavor. The question then immediately arises: What is good organization? An attempt will here be made to answer this question with no intention primarily of treating the subject with any completeness, with no great hope of aiding the ignorant, but merely as a possible guidance to those interested in furthering a better organization. I will briefly outline what my experience, in the formation of and as executive head, of different organizations, has proven to me to be some of the essentials, and some of the pitfalls into which too large a percentage of minor executives fall.

*Colonel Ardant Du Picq states that "Man is an incomparable instrument whose elements — character, energy, sentiments, fears, desires, instincts— are stronger than all abstract rules, than all bookish theories." Since man constitutes the personnel of an organization, it becomes necessary to use this instrument individually and collectively for the best interest of the object sought. In our organization of maintenance the object is to realize the best results in beneficient accomplishments as to safety, comfort and appearance of our highways with the minimum of waste—waste either of men's efforts or of public monies.

Personnel in General.—Personnel is the foundation and superstructure of all organizations. Weakness in personnel means lack of stability throughout the entire structure. Now, this lack of stability spells waste, and waste covers almost all the sins of the day in the conduct of public affairs. When an organization, through its personnel, allows unproductive effort by expending unnecessarily or carelessly men's efforts or public money, it not only wastes money and effort directly, but what is far more harmful, it also undermines the morale of the personnel of its own organization, and this equally corrupts all that come in contact with it.

To understand better this matter of personnel, it seems a correct, or at least a good method of procedure, to take up not only the desired characteristics a man should possess who heads a subordinate part of an organization, with authority to give orders and with responsibility for this execution, but also those characteristics desired on the part of the entire personnel. Some of these are as follows:

Physical Qualities.—Physically a man must be healthy, clean, neat, with plenty of energy, and sufficient endurance to take care of an emergency situation. He should also have such a bearing that he not only is able to give orders, but is accustomed to give them. These qualifications can only be acquired by experience, for men readily perceive the pretension of such experience and naturally resent being practiced upon. Neatness is very essential, since it will permeate the entire organization even to the common laborer. Further, neatness and care of person usually mean neatness and care of the work.

Honesty.—Intellectual honesty is another qualification absolutely essential. As to monetary honesty, practically everybody is honest, or such a large percentage of men are, that this phase can be passed over. What I mean is that the personnel should be encouraged to tell the truth about all matters, whatever the effect may be; all should be honest to each and all, for they are living a similar life, sharing the same, or very similar discouragements. Hence, co-operation should exist among them so that they may quickly understand each other in their execution of orders, and in professional knowledge. Such conditions alone will bring about unity in which falsity, quibbling, and hurtful gossip can have no place.

Under this question of intellectual honesty, the reputation for fulfillment of promises, either as an organization or as members thereof, is one of extreme importance. The personnel must be instructed to fulfill every promise made, but must be careful of the promises made. Once upon entering the duties of a new position, I found many of the public had lost faith in us. It seemed that it had been the custom of this particular section to take the "easiest way" by promising many things quite impracticable to fulfill, also many things that could have been fulfilled, but no effort was made to do so. Upon my taking charge orders were immediately given to change this questionable policy at once. "Keep your word when given," was the positive order. Within six months confidence was so well established in those with whom we had contact that our word was no longer questioned. This change expedited our work, prevented a material waste, and inculcated in the personnel a moral responsibility that gradually became a part of all their activities.

In this connection sometimes the Mediterranean-spirit-of-trading cleverness has shown itself. This should be discouraged at once. We in public life are not traders. We want no financial advantage from any man. Among the ignorant—the word ignorant is not used here as indicating lack of educational advantages—it is often considered quite smart to be tricky, especially with those under them. In this way they get just a little more than is paid for. They are under the false impression that by so doing they are so much more valuable. But just the contrary is true. The monetary gain therefrom is a myth, as every man will "get even" one way or another. The greatest harm, however, is the effect upon the entire morale. They all soon become tricky, with the resultant stupid waste of energy and monies.

Discipline.—Almost every man is proud to accomplish something the eye can see, and, however small, the pride of achievement is thereby developed. There is but one aristocracy: that is the aristocracy of accomplishment. It is proud as all aristocracies are. If it were not proud, it would lack confidence, and lack of confidence will kill the efficacy of any organized body of men. This pride in accomplishment automatically solves the matter of discipline. By discipline I do not mean punishment, but rather an adjustment of an individual to the purpose of an organization. All such adjustment becomes easy when a sense of pride, rather than of fear, is appealed to. No two men are alike, so an efficient executive must exercise the utmost patience in the development of his personnel. Of course there are men who must be eventually dispensed with, since it is simply impossible to place them where they can or will be interested sufficiently in the working and the aims to become positively useful.

However capable in technical practice and education a chief or subordinate chief may be, economic accomplishment will fail if the entire personnal cannot conduct itself without being watched,

*"Battle Studies," translated from French by Colonel J. N. Greeley and Major R. C. Cotton.

and if it is not personally animated by an almost unconscious resolution to do its work to the best of its knowledge. This brings us to the question of morale, which depends in turn upon such factors as zeal, hope, spirit, and confidence. There must be from top to bottom no intellectual idleness, which is mainly brought about by servile submission. Rather there must be inculcated and developed an individualism controlled by a reasonable and constructive discipline.

Courage.—Fear is unquestionably the greatest hindrance to progress in any line of human endeavor. Therefore a very important element is the development of courage. This courage enables men to do things without which they would otherwise become merely "pay waiters." Franklyn K. Lane, secretary of the interior under President Wilson, made the following statement in this connection: "Ability is not lacking, but it is pressed to the point of paralysis because of an infinitude of details and an unwillingness of the part of the body of public servants to take responsibility. Everyone seems to be afraid of everyone else. When the self-protective sense is developed abnormally, the creative sense atrophies. Trust, confidence, and an enthusiastic courage are the three simple virtues of all great businesses, and are the ones most lacking in governmental organizations. Every man is held to the details of the narrower point of view. This comes too often to be a departmental view or some sort of a parochial view." Secretary Lane knew, as we all do, that such conditions result in almost incalculable waste. How are we to avoid this waste in our organization? Can it be done? Yes, it can; not to the fullest extent desirable, perhaps, but gradually and unquestionably it can be done if we obtain the desired personnel or develop that we have and root out and keep rooted out all that type of men whose fear is their only incentive to right action.

Many times in handling public organizations, the fear or the antagonism of politicians has been expressed. By the term "politicians" it is usually meant those men who have been chosen by the body politic to represent it in carrying on the public affairs. These are usually outstanding men in their communities, and as such are interested in public work, and especially so if it is a basic engineering proposition. If the engineer has practical knowledge of his work and the intellectual capacity to express in understandable English the objects sought in his particular activity, he will usually find that these politicians are not only interested in his work, but will endeavor to aid him in every way they can. The personnel should understand this and should prepare itself to explain and elucidate concisely and intelligently all situations in which it is personally involved.

The motto, "They will talk anyway," is cut into a board that hangs above the porch of the Roycroft Inn at East Aurora, N. Y. If we in charge of public affairs are going to worry and trouble over "what they say," we had better get into some other line of endeavor.

Square Dealing.—Another necessary procedure in establishing confidence is to have no secrets, no atmosphere of mystery. From lowest to highest, an executive should have in his mental possession the aims of his organization, with all necessary details so that he is not compelled to work in "the dark." He should have a clear understanding of the mental attitude of his immediate superior relative to himself. Men should be told frankly of their peculiarities that are a detriment to their work, with a concrete example of just how this peculiarity is detrimental. Since we cannot standardize men the same as we can nuts and bolts, it behooves us to study closely the temperaments of our personnel. Almost every man will react favorably to this method. Some will not comprehend it as soon as others will, but all, or at least the great majority, will; and those who cannot or will not, should seek some other line of endeavor.

This recognition of men's worthy accomplishments should be expressed in words that convey real appreciation. A man unable to give or who will not give a compliment cannot be a good executive. He may hold an executive position but he is not a good executive leader. Often you hear a man express the thought, "If you praise men, you spoil them." This is a fallacy; all men like appreciation and respond to it. As a matter of simple justice they should receive it. If they become spoiled, an able executive can easily restore them to a normal state of mind. But very few are spoiled.

Self-Control.—Another thing harmful to the general morale is emotional thinking or talking. True, man, being a social animal, cannot easily divorce himself from his likes and dislikes. Yet a competent executive, irrespective of his personal feelings, must give preference in compensation, consideration, and expressed ideas to the men who have "produced the goods." He should know by investigation and by facts who have done so. In all this the avoidance of favoritism based upon any ulterior motive should be strictly adhered to. Any other method has the effect of elevating the incapable at the expense of the efficient. It is needless to state that such tactics ultimately produce wastefulness.

Getting unduly excited over an incident previous to making at least a casual investigation of its why and wherefore breeds disrespect more than any other thoughtless action; and disrepect kills morale.

The Handling of Men.—Orders, both oral and written, should be concise and positive, should omit all unnecessary phraseology, and should, under no condition, be nullified by "buts," "ifs," or "ands." I know no better way to disrupt morale than to give long written orders phrased so much in detail as to become an insult to any reasonably competent man. Such a man resents, and rightly so, being treated by the pedogogic method of the schoolroom. The man issuing an order must have a definite idea of what is intended to be accomplished, a fair idea of some of the more important details, and a determination to have the task accomplished in a specified time. Subordinates should be told definitely what is to be expected of them, but should be left to their own method of execution unless such methods prove faulty and can be improved upon by judicious suggestions. Leave your subordinates alone to work out their own salvation, give them a chance to work out their own ideas. Many a business failure is due to the boss' dabbling into every activity and detail. When a man in an executive position constantly interferes with his subordinates, it is immediately indicative that his judgment of men is faulty and that he lacks self-confidence.

When a man thinks he must do all the detailed work himself, something invariably suffers. Often you hear men say, "If I leave the work for a day, something is sure to go wrong." This admission is proof that the man is not a good executive. He should know the work will allow a reasonable absence at almost any time. A maintenance supervisor should give his superintendents a free hand, not necessarily to supervise actively his men, but actively and carefully to supervise the results. An associate in my work said to me the other day, "These men are on to you now." Of course they are. If they were not, probably they would be working somewhere else. It takes time and patience to form and drill an organization into shape to perform economically. After this is accomplished, the men must know you, and you know the men. Surprise was at first manifest on all sides when this organization started that the superintendents were not interfered with continuously. At last one of the superintendents remarked, "You believe in giving a man all the rope he wants, but that if he goes too far he will hang himself." That was exactly the idea I had in mind. If men could not conceive their job with freedom of action, the time to find it out was in the initial stage of development. This fact could not ever have been discovered if freedom of action was denied them and every act was simply blind following of instructions. In place of men in such circumstances, we should have manikins. Manikins have no initiative. Care must be taken that initiative is not taken from minor executives.

In this connection we might follow the "chain of command" as used in the army. This should be followed without deviation in every organization. Each man should know who is giving him orders, and no man should receive orders from two sources under any circumstances. Too many times this interference occurs in civil life to the injury of the morale because it gives rise to gross satires. These in turn will bring the whole organization into derision.

Qualities Desired.—Moreover, harmony and enthusiastic co-operation must be developed and encouraged. Care must be exercised not to destroy the zeal and attempt of each subdivision to outdo the other in achievements in a perfectly friendly spirit of rivalry and without discord. "Yes-yes" acquiescence in the chief's suggestions is not indicative of harmony, but rather of an intellectual indifference, of laziness or even lack of courage on the part of the subordinate to express his ideas if he has any—all of which tends to stultify individual ideas and actions. These ideas on the contrary should be encouraged to the fullest extent, as the personnel of an organization is, or should be, composed of thinking men whose thoughts, individually and collectively, should be for the best interests of the work. Without expression of these thoughts there are no means to take advantage of progressive ideas nor to correct erroneous ones: both of which are necessary to develop our personnel to a point of enthusiastic interest in its efforts. To repeat, maintenance work cannot be economically performed by making machines out of men. The distribution of men over considerable territory prohibits this in our field. Many experienced, minor executives are laboring under the delusion that automobile organizations aiming at mass production should be copied in all kinds of human endeavor. This not only cannot be done; in my opinion it is undesirable that it should be attempted. While on the subject of the "yes-yes" type of men, let me add that it is known that a few big executives are employing a hard-boiled, intellectually honest man of experience in human affairs to confer with this executive frequently for the purpose of analyzing his actions and conclusions and advising misjudgments. This method gets the executive "back to earth" in case his exuberance over personal endeavors has overcome his intellectual poise. It is too bad more do not do this very thing. Undoubtedly, it will be on the increase as our big men get tired of being "yes-yessed." The bigger the man the more readily he realizes the truth of the maxim, "To err is human." Many times in the first stages of our organization I have given voice to fallacious thought for the sole purpose of discovering whether the men were interested more in "standing in" with me than they were in the good of the work. This experiment resulted in a more intelligent interest and in better results.

Decision.—The procuring or the development of men of courage to make decisions and of sufficient intelligence to execute them is another important item of personnel. In our work, emergency situations arise frequently. These require quick action. Therefore we must eliminate from our organization all the "pro" and "con" men, the "maybe" men, and the "perhaps" men. These last types are the ones that always see what might happen if such and such were the case, that always look for extreme difficulties, and that waste time talking about what to do instead of first getting busy and doing the job. Talking about the situation after the emergency has been corrected is justifiable and desirable. Men in maintenance organizations must be trained to be men of prompt action, free from hesitation or vacillation. They must be "go-doers" in place of "go-getters." "Go-getters" do not fit into this kind of work; that phrase is more applicable to salesmen, perhaps, than to maintenance men. What I mean is well illustrated by the recent attempt to cross the Atlantic Ocean in a "flying ship." Commander Byrd was handicapped by scientific and bureaucratic niceties, Chamberlain by the "go-getter" backer over monetary considerations. "Lindy" just started while the others were getting ready and he succeeded. Chamberlain did arrive in time, it is true, but Byrd never did. He fell into the sea.

Straightforwardness. — Discourage gossip. Gossip breeds mischief, while loyalty conteracts the poison of envy and strengthens efficiency. This term "loyalty" is a word used so commonly and carelessly today that it has lost its real significance in the minds of many. A far too large percentage of people consider loyalty as a mere personal matter. Rather, it should be primarily loyalty to the work. Loyalty to personnel over whom you have control is of prime importance and should mean that your men are treated with fairness, impartiality, and honor. All men appreciate just treatment. My experience has taught me that justice to men is one of the prime essentials of good morale. A man will stand discipline, censure, and criticism if it is just, but let an element of favoritism, or injustice, enter into your relations with your subordinate personnel, and you have ruined your morale with the resultant waste. Loyalty to your superiors means respect of their aims, and a whole-hearted effort to help them attain their objects. One must not be simply passive to his superiors; he must help by presenting ideas and suggestions that he thinks will aid. The nonagreement with your suggestions should not be discouraging or exasperating (all men's minds are not the same). Another man's thought may fit perfectly into your conditions as he sees them, so let him present it. Loyalty to all, both below and above you in an organization can be summed up in the slogan, "A square deal for all."

Inspiration.—Initiative, self-reliance, and loyalty have already been touched upon. There yet remains another qualification—"the ability to inspire men." This ability often is overlooked in public organizations. To get this, first get the men interested in the work itself by explaining the object of every activity. Do not lecture them, avoid criticising, and, above all, never indulge in fault-finding, as this incurs antagonism, which antagonism will react injuriously to the morale of any body of men. Let them feel the well-known principle that they constitute the "organ of execution" and that the success of the departmental activities depends upon them as subordinate units. If they are the right kind of men they will feel this responsibility and carry it down to their subordinate units. Hence, when they all feel it from top to bottom they will be inspired with a feeling of responsibility and pride of accomplishment. No executive, large or small, need worry about the execution of his plans when his subordinate units are inspired by such incentives.

General Qualifications.—Let us now look into the general qualifications of supervisors and superintendents. The first of these is professional knowledge. This is not only desirable on the part of superintendents, but is essential to a competent supervisor. Under this head we may class collegiate training, which amounts to about 15 per cent of it; the other 85 per cent would be classed as knowledge acquired by experience and intimate contact with actual operations. Although this 15 per cent is small, it is nevertheless necessary.

Skill is also a very necessary requirement for superintendents. Now, this skill cannot be acquired by educational methods alone, but rather comes either intuitively or by long experience in trying different methods on some work, or by watching closely someone else of greater skill.

Desirable Relationships.—The economic relationship of equipment to a personnel is also of utmost importance since too many of the even so-called practical men are laboring under the delusion that all one has to do is to buy a machine and at once the work will proceed economically. In the last analysis the personnel will be the determining factor as to whether this particular piece of machinery will be satisfactory, provided judgment has been exercised in the procuring of the type. No man can make a misfitting piece of equipment produce good results.

There must in addition be an intimate and cordial relationship between the maintenance supervisor and his superintendents. In our organization the superintendents assemble in the super-

visor's office every other Monday. Here general matters pertaining to the past two weeks are reviewed and situations are anticipated which may arise before the next meeting. But the most important result attained is the training of men to talk on the subject under discussion without wandering over a half dozen other subjects. The doing of this at first occasioned an apparent discourtesy on the part of the maintenance supervisor, as it became necessary for him to shut off extraneous conversation. But it soon helped materially to produce quick, concise, accurate thinking and expression. This meeting soon became able to do all necessary business in less than a half hour. The average conference, whether in high councils or low, is a waste of time, due to the unbridled tendency of men just to talk all over and beyond the subject under immediate discussion. Such desultory talking tends to prolong and waste time with but little, if any, final decision. The average conference is about ten times as long as is necessary. This is why "conference" has become a joke in the minds of newspaper paragraphers. The relationship of supervisors to superintendents has been outlined. Similar relations should exist between the superintendent and foreman, and between the foreman and his men. And how about the relationship of the supervisor to the chief of maintenance? This should be direct to the maintenance supervisor with the aid and assistance of an engineer; call him by what title you may, but he should correspond to a staff officer of the army. From instructions to a staff officer the following excerpt was taken which I have the temerity to quote, since it appears to me to be opportune:

"He should report only facts concerning situations and conditions. He must under no circumstances meddle with responsibilities. He must bear in mind the cardinal principal that the staff officer serves his commander best when he helps the troops most. His first concern, both during his visit and in his subsequent report is the needs of the troops in connection with their situation and condition. Every visit or inspection should include the question, "Can headquarters do anything for you or help you in any way?" His visit will be welcome and fruitful if, following his preceding visits, he has carried these needs to the commander and has followed up the measures necessary to obtain them. His value to his commander increases enormously when a unit welcomes his arrival, feeling sure that he is bringing newer and better ideas and that his report will show the things that are being well done in the unit. Adherence to these principles of procedure will result in the troops regarding him as their representative with the commander, the very acme of staff efficiency in this respect."

There is still another feature of personnel that we are all familiar with, but its economic value is of such great importance that it will bear repeating, as it is applicable to a maintenance organization. It is this: Do not change the personnel except when absolutely necessary, and only after detailed consideration of every phase of that change, as such a change, if not compulsory, will cause in most instances irredeemable waste.

Conclusions.—Why is the above written? Because an adherence to these principles, since every one of them has practical value, will prevent a wastage of public monies far in excess of what a casual observer realizes. Not being afflicted with the vanity of modesty, I will say that I know we have prevented a wastage equalling at least 10 per cent of the payroll expended on maintenance in the last two years, and I know that any maintenance chief, county or state, can do the same by following these suggestions if he is not already doing so.

This matter of waste is coming more and more to the front in our public life. This is well exemplified by a recent election in a Pennsylvania city where a socialist candidate defeated nominees of both the old parties on the simple question of wastage of public monies. Again, if my recollection is correct, in one or two states a self-appointed body of citizens is making a detailed investigation of the state organizations with this one idea of preventing waste. Then let our department keep this continuously in mind and make every effort to prevent a condition that would subject us to just criticism. Let us also keep in mind that old adage about "Saving at the spigot and wasting at the bung hole."

The people are not stingy; they gladly pay the way without worry or criticism, if satisfactory results are shown. They are not interested in the technical details of a proposition. But they do want to see an improvement in the safety, comfort, and appearance of our highways. And we will continue to improve if we can inspire our personnel with the three simple virtues of trust, courage and enthusiasm.

Safety First in Bidding

The following suggestions are reprinted from the Highway Builder:

There is an old aphorism which says "Many go suddenly blind when opportunity stares them in the face." Like other "Saws" and sayings, this doctrine is susceptible of both a positive and negative interpretation. The purpose of this preachment is to treat the negative side as it relates to the submission of bids by highway contractors. And it is with that thought in mind that we propose an aphorism, negative to the above, which might read: "Many bidders go blind because of opportunity which they assume to be staring them in the face."

It is one thing to have opportunity staring you in the face and another to think it is staring you in the face. So that after all the use and interpretation of wise sayings similar to that first quoted herein is closely related to the parable of the "Baby and the Buzz Saw" and those without judgment will seldom be benefitted by such things. Therefore, in furtherance of our purpose, we inject another aphorism, widely heralded in safety campaigns which says "A moment of carelessness may mean a lifetime of regret," followed by some "Don'ts" for bidders as a sort of safety first bidding target at which they may shoot.

Don't figure too close to the border line between profit and loss. Remember that the only safe way you can identify this border line is through your own costs obtained previously in the prosecution of similar work.

Don't attempt to establish this border line through vicarious information or suggestions. Such things, particularly where received from persons expecting to profit from your buying requirements may be too optimistic. To follow them might crush your mind, body and family.

Don't forget that a contract is like a moving train; it is difficult and dangerous to alight after it has once started. Don't fail to get into your contract on the safe side of the bidding road. The other track is frequented by temporary price pace-setters who drive without brakes or safety signals.

Don't let the necessity for renewing loans at the bank induce risky bidding. If you are faced with that temptation, it is time to stop, look and listen. It means you are doing business on a "shoe string" and that only an ample margin of profit can save you. Yielding to such a temptation merely postpones the day of accounting and magnifies the final crash.

Don't bid on jobs you haven't looked over in the field. This advice sounds foolish, but public officials say you are doing it and then criticising contract provisions and making unnecessary trouble because you lose money.

Don't accumulate plant beyond that absolutely required for efficient operation; otherwise you may not be able to earn depreciation on it and the sheriff may have to assist you in its disposition.

Don't fail to charge amply for plant depreciation so that you will have money to buy more when what you are now using is obsolete or worn out.

Don't pay attention to gossip around lettings as to what others will bid and don't make up your bids in such an atmosphere. Making up bids around hotels just before lettings is like putting one's head and arms outside a railroad car and incurring the liability of getting them knocked off.

Rock Asphalt Top on Concrete Base Paving on Louisville Boulevard

Utility Mains Placed in Grass Plots Paralleling Paved Area

By W. J. HORRIGAN

W. J. Horrigan & Associates, Inc., Consulting Engineers, Louisville, Ky., and Engineers for Board of Park Commissioners, of Louisville

THIS boulevard, known as Western Parkway, is the principal and only direct route in the western section of the city connecting North and South Louisville. It is also important from the fact that it connects two of Louisville's most beautiful parks—Shawnee and Iroquois. It is about 5 miles in length, and, in general, passes through undeveloped territory. However, a portion of the territory is being developed as an industrial section and among the important industries is that of the Ford Motor Car Co., which has one of the largest plants in the south located on the parkway.

The parks and parkways of the city are under control of the board of park commissioners, consisting of six members appointed by the mayor, and under existing regulations the type of traffic permitted on parkways is limited to light delivery trucks, with pneumatic tires. Inasmuch as the greater portion of the territory adjoining the parkway is ideal for industrial plants, the board of park commissioners is compelled to construct a type of pavement capable of carrying heavy traffic, in order that the type and amount of traffic will not have to be restricted.

General Features.—The width of the parkway is 120 ft. between building lines, and the improvement was designed so that the roadway, including curb and gutter, is about 37 ft. wide, leaving 83 ft. (or 41½ ft. on each side) for grass plots and tree planting. With this in mind, plans and specifications were prepared for a roadway surface 33 ft. in width, with combination concrete curb and gutter, the curbs being 6 in. in width and the gutters 18 in. in width. Bids were received on four types of surface, as follows: Reinforced concrete, Illinois type; sheet asphalt; asphaltic concrete on concrete base; and rock asphalt on concrete base.

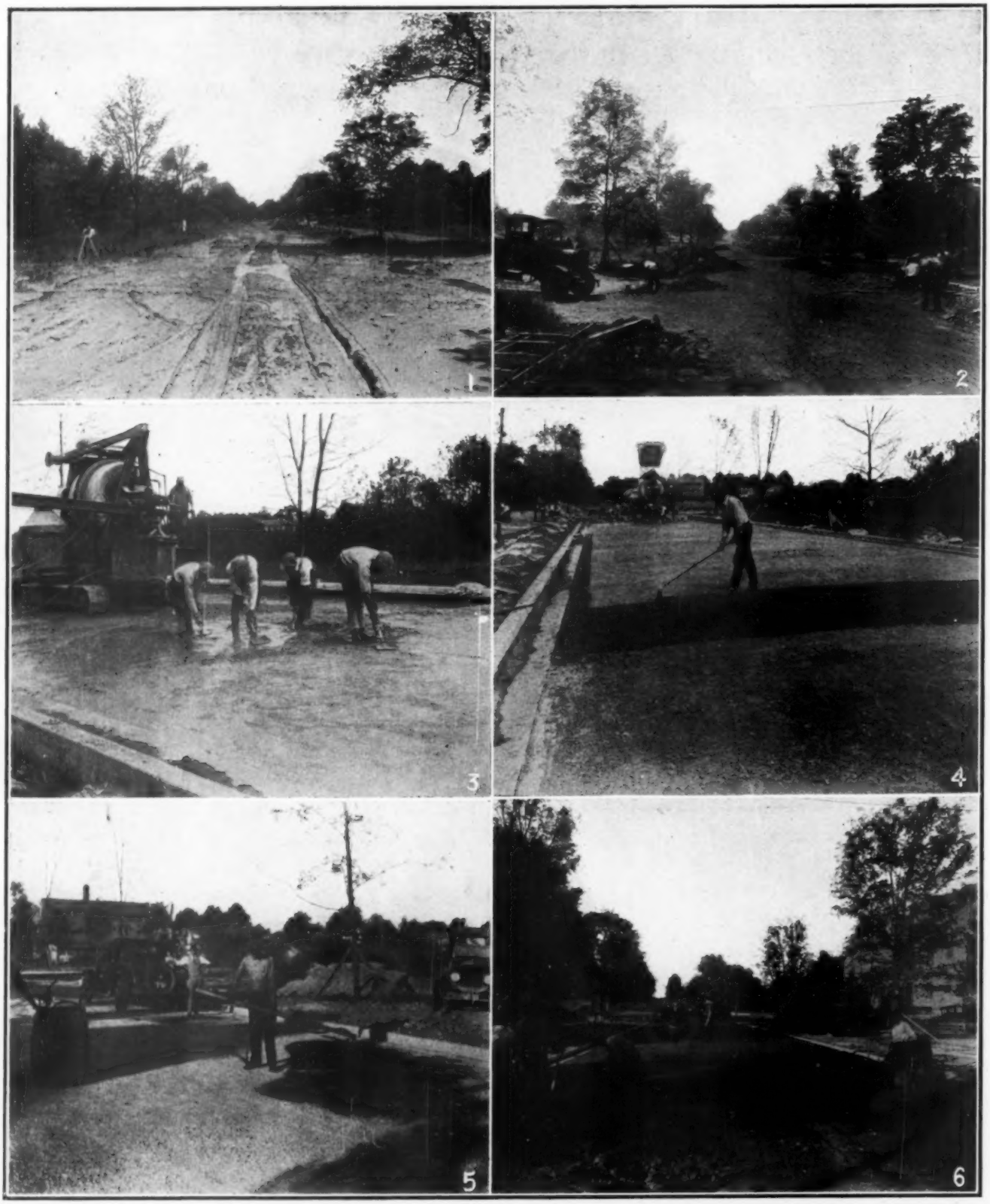
The board of park commissioners after careful consideration, selected the rock asphalt surface.

Construction Details.—The curbs and gutters are of the combined type and constructed of plain 1:2:4 Portland cement concrete.

The roadway paving consists of a 6-in. 1:3:6 gravel concrete base with a 1½-in. compacted Kyrock wearing surface. The concrete was mixed for the base by a Smith paver and after being spread and finished to the proper thickness and contour, was smoothed in such a manner that no point varies more than ¼ in. from the true contour. The base was finished smooth in order to secure the maximum carrying capacity of the full thickness of the base. Before obtaining its initial set the surface was slightly roughened by means of a rattan broom, operated transversely, so that the corrugations are at right angles to traffic. It was then allowed to cure for about three weeks. Immediately prior to laying the Kyrock the surface was painted with an application of "cut-back" asphalt, for the purpose of securing a clean surface and bond with the base.

The Paint Coat.—Considerable discussion took place as to the value of a paint coat. Some experiments were made and it was discovered that the use of paint coat enables the Kyrock surface, which is somewhat friable, to grip the concrete surface in a manner not obtained when the material was

View of Western Parkway, Louisville, Ky., Showing the Completed Pavement Construction Features of Paving Western Parkway, Louisville,



Construction Features of Paving Western Parkway, Louisville, Ky., with Rock Asphalt Top on Concrete Base

(1) Condition of Sub-Grade Over Which the Boulevard Had to Be Built. Considerable Filling Was Necessary in Places. (2) Excavating for Combination Curb and Gutter. (3) The 6-in. Base of 1:3:6 Gravel Concrete Was Finished to Full Depth, Tamped with Shovels and Finished Smooth on Top so That No Point Varied More than ¼ in. from the True Contour. (4) Before the Concrete Base Had Obtained Its Initial Set, the Surface Was Slightly Roughened by Means of a Rattan Broom Operated Transversely So That the Corrugations Would Be at Right Angles to Traffic and Thus Afford Better Anchor for the Kyrock top. (5) Immediately Prior to Laying the Wearing Surface, the Roughened Concrete Base Was Painted with a Light Spray of Cut-Back Asphalt to Cement the Dust and Loose Particles Resulting from the Roughening Process, in Order to Insure a Perfect Bonding of the Rock Asphalt with the Base. (6) The Rock Asphalt Was Dumped on the Painted Base Directly Behind the Shovelers. Sheet Metal Guides Were Used to Enable the Rakers to Secure Uniform Thickness in Spreading. The Guides Were Pulled Forward on the Base as the Work Progressed. The Section in the Background Has Received the First Rolling.

placed on a non-painted base. The rock asphalt was spread in the usual manner, with the exception that sheet-metal guide strips were placed at the center and quarter points to secure uniformity in spreading. After raking to grade, the Kyrock was permitted to remain without being rolled until the following day. It was then rolled with a tandem roller.

No Utility Mains in Paved Area.—One interesting and important feature of the roadway is the fact that the pavement area is free from utility mains, such as sewer, water, and gas below the surface. All such utilities are placed in the grass plots adjoining the roadway area. In addition to eliminating a possible base failure over the trenches, regardless of how well back filled, it prevents the pavement from being opened at any time to insert house connections or repairs to mains. The fact that very few residences and other structures now exist, the practice of placing the utility mains in the roadway and extending house connections to the curb line was not possible. Experience of over 20 years has taught us that connections inserted a considerable length of time before property is developed are rarely in the proper place for the building. Inasmuch as considerable building is expected on this parkway during the next three years, this pavement would be a mass of repaired openings rather than a smooth finished and pleasing surface.

The contractors for this project were: J. U. Schickli & Bro., Inc., who performed the excavation, curb and gutter, concrete base, drainage, etc.; R. B. Tyler Co., W. N. Bosler, chief engineer, laid the Kyrock wearing surface. W. J. Horrigan and Associates, engineers, were represented by W. W. Pardon and N. R. Guthrie, Jr., resident engineers.

Caterpillar Tractor Company Announces New Model

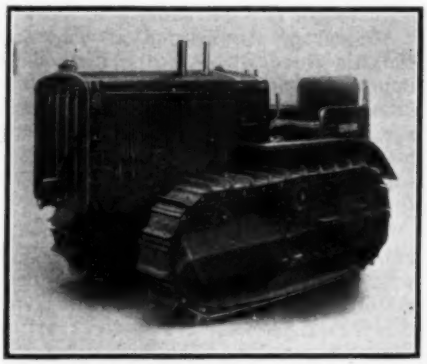
The Caterpillar Tractor Co., of San Leandro, California, and Peoria, Ill., announces a new model tractor designated as the "Caterpillar" Twenty. The new model takes its name from the fact that its rating is twenty horsepower at the drawbar.

The Twenty is a new tractor in size, rating and price, built to fit into a line of bigger brothers, the Thirty and the Sixty, as well as the smaller 2-Ton, and to supplement these models in agriculture, contracting, lumbering, muncipal work and in industry, according to engineers of the company.

It represents the cumulative engineering experience of more than forty years of tractor manufacture to meet the demands of tractor users in practically every country in the world. Engineers of the Caterpillar Tractor Co. state that they spent two years in designing, building and testing the new model under the most adverse field conditions before finally putting it into production.

Following are the specifications of the new model: Engine—Bore, 4 in.; stroke, 5½ in.; R. P. M., 1,100; Valves—Exhaust head diameter, 1-23/32 in.; stem diameter, 7/16 in. Inlet, head diameter, 1-29/32 in.; stem diameter, 7/16 in. Brakes—drum diameter, 11⅝in. Band width, 3 in.

Fuel—Gasoline. (In countries where gasoline is unobtainable or where its price is unduly high in comparison with other locally obtainable fuels, distillate, kerosene, alcohol, etc., can be used. Information regarding the use of such fuels furnished on request.) Fuel tank of 22 gallons capacity.



The New Caterpillar That Develops a Drawbar Pull of 20 Hp.

Flywheel Clutch—Drives upper transmission shaft through all-metal double universal connection. Two friction surfaces. Clutch plates 14 in. diameter. Friction surface area, 115 sq. in.

Transmission—Selective gear type, three speeds forward and one reverse. Single reduction in all forward speeds.

Steering—No. of plates in each clutch 16. No. of springs, 8. Diameter moulded lining, 10¼ in. Area friction surface each plate, 44 sq. in.

Track—Width of track shoe (standard), 11 in. Height of integral grouser, 2¼ in. Diameter of track shoe bolts, ½ in. Diameter of track pin, 1-5/16 in. Diameter of track pin bushings, 2 in. Grease Pump—Capacity, 25 lbs.

Ratings—Engine speed, 1,100 R. P. M. Drawbar horsepower, 20. Belt horsepower, 25.

Speeds—Low, 1.79 M. P. H. Intermediate, 3.07 M. P. H. High, 4.67 M. P. H. Reverse 2.26 M. P. H.

Dimensions—Over-all length, 115.5 in. Over-all width, 61 in. Over-all height, 60.5. Tread, 42 in. Ground clearance under transmission, 12 in. Drawbar height above ground, 15¾ in.

Net weight (approximate)—7,000 lbs.

A variety of special equipment is provided for the new model to meet all special requirements of owners. Special track shoes may be ordered in place of the standard 11 inch shoes.

A spark arrester offers maximum protection against possibilities of sparks coming from the exhaust. A front pull hook is available as it is often useful for pulling loads in reverse gear. Lighting equipment includes powerful headlights, with brackets and necessary wiring. This equipment can be furnished applied at the plant, or boxed for field installation. Bracket bolt holes are tapped into radiator side plates and in the fenders at the rear of the tractor, to enable the owner to locate lights to suit his convenience. Current for the lighting system can be furnished either direct from a generator, or by a generator and storage battery system. For belt work, a stationary drive can be attached to the rear of the transmission case, this unit connecting directly with the upper transmission shaft. The new model develops 25 belt horsepower. A power take-off can be provided for use with various equipment that is designed to be operated, as well as pulled, by a tractor. The new model can be equipped with a power take-off at either the front or rear.

The summer top and cab equipment is of the quickly convertible type. The summer top consists of an angle iron frame and curved top over the driver's seat. This is easily converted into a completely enclosed cab by the addition of sides and doors or curtains.

An electric starter, with a floor button, starting motor and starter flywheel ring, can be installed. The company advises that this equipment be ordered attached at the plant; but starter ring shrunk upon the flywheel, together with motor and accessories, can be supplied for field installation. The use of an electric starter, of course, necessitates that the tractor also be equipped with generator and battery, which can be used both for starter and the lights.

Street plates can be furnished for conditions that make the use of a smooth track surface necessary or desirable. These plates bolt to the standard shoes and provide a flat ground contact without projecting grousers or bolt heads. The Twenty can be equipped with a muffler on the exhaust. An odometer, which registers distance traveled in miles, can be fitted to the Twenty to aid those tractor users who desire to keep accurate work or cost records. A special carburetor can be supplied when alcohol is used for fuel.

Ice Roads Built in Russia.—The results of building ice roads along the Murmansk railroad in Russia during the past winter were very successful, according to "Economic Life," Moscow. One of such ice roads built in a forest near the Zheleznaya Mountain effected considerable savings, and at the same time increased the capacity and amount for hauling of logs from the forest. A number of such ice roads will be built in other forest districts adjoining the Murmansk railroads.

Bituminous Treatments of Earth and Gravel Roads

Experiences in Minnesota Described at 17th Annual Wisconsin Road School

By H. G. NICHOLSON
Assistant Engineer, Minnesota Highway Department

SINCE the material in the road bed is the first problem to be considered in building up a road, Minnesota and other glaciated areas afford a much wider field for study and experimenting. In some parts of Minnesota the prevailing subsoil is a clay or gumbo while in other districts the material is granular. Samples of the road beds have been taken and analyses have revealed materials ranging from 99 per cent clay and silt and 1 per cent sand to the other extreme of 99 per cent sand and 1 per cent clay and silt. Between these extremes, innumerable proportions of sand and clay and silt exist. To complicate conditions further the sand may consist of a fine "blow" sand to a sand or gravel containing boulders, while the clay in some districts is a light yellow residual as in the southeastern part of the State, or a dense, sticky gumbo from glacial Lake Agassiz in the western and northwestern part of the State, and between these areas we find the third general classification of transported clays of glacial origin and silt.

From experiments carried on both in the laboratory and in the field, the class of bituminous materials most suitable for different types of soils is becoming fixed. Tars and road oils of a cut-back nature are being utilized on soils of a granular texture, while road oils of a low volatile characteristic are applied where the percentage of clay is in excess, and more especially on sub-grade treatments. Experimental work is not dropped after the initial treatments but is carried on further along lines of maintenance and construction.

Tar and cut-back asphaltic oils or, more specifically, asphaltic oils of a high volatile content have been pretty well established for gravel roads, and practice common to other states is used with a few variations. It must be remembered that conditions of roads in this state, as in other states where cheaper roads have been constructed, are far different from roads in states where heavier construction has been carried over a long period of years. Gravel roads in this state consist of a thin crust of gravel compacted with clay as a binder and not consolidated or water-bound macadam of 6 in. to 2 ft. in thickness. Therefore, practice to us has to conform to existing conditions. In most construction a 30 ft. grade is carried, but only 24 ft. treated. The traffic ranges from 600 to 6,000 vehicles per day on roads to be treated.

Method of Application of Tar and Volatile Road Oil.—As the method of application of tar and oil of a volatile nature is carried on in the same manner, we will discuss them under the head of tar application to avoid confusion in terms but bearing in mind that either may be used.

The roadway is first bladed smooth and true to cross-section by means of a 10-ton tractor and a 12-ft. blade or a motor driven patrol grader, care being taken to disturb the compacted crust as little as possible. The former is preferable as a smoother surface is obtained. The loose gravel on the roadway is then bladed to the shoulder on which the additional cover material has been previously placed. The cover material with the gravel salvaged from the road surface amounts to 325 to 375 cu. yd. per mile. The gravel is material which will pass a ¾-in. screen and does not contain an excess of fines.

When the roadway is in this condition the application of tar is in order. In some cases sweeping the surface is reverted to but only when the base is firmly compacted to a depth of 5 in. or more. This, you will note, is a deviation from the older practice.

Half the roadway is treated at a time to afford room to carry the traffic at minimum inconvenience. Where the width of the roadway does not permit the wind-rowing of the gravel on the shoulder, the cover material is windrowed in the center of the road or just a little off the center away from the side being treated. This often tends to keep the traffic off the side being treated but additional care must be taken to avoid a weak strip in the center of the roadway caused by too much loose gravel preventing the penetration of the tar into the road bed.

An 8 ft. width of tar is applied immediately next to the wind-row of gravel at the rate of three-tenths to five-tenths gallons per square yard. One to two miles is covered in this manner. A power patrol precedes the distributor to blade off as much of the loose material as possible. This application or prime coat is applied at a temperature of 135°F. to 150°F. A 4-ft. width is applied adjacent to this and the half of the roadway is allowed "to set," the tar penetrating into the road bed. This usually takes from one to ten hours. The work can be laid out in such a manner that this setting action can take place over night.

The second half of the roadway is then treated in a similar manner and traffic is carried on the side with the prime coat. The tar does not pick up but the weak spots are brought out and can be patched before the seal coat is applied. The only variance in treating the second side is that a 4 ft. strip is applied next to the side with the prime coat making a lap of about 6 to 8 in. The an 8 ft. spray is applied adjacent to the four foot spray. This enables the distributor to travel on roadway free from tar.

When the second side has "set" sufficiently to handle traffic without "picking up," the applying of the second or seal coat is in order. Traffic is then diverted to the side not receiving the second coat. Again starting next to the wind-row of gravel an 8 ft. width is applied at the rate of three-tenths gallons per square yard. This is applied at a temperature of 125°F. A power patrol equipped with rubber tires immediately pulls the gravel over this application, spreading the material about one to one and one-half inches deep. Care should be taken not to load the patrol with too much material as a side thrust on the machine will be detrimental to the surface. There is plenty of time between loads to make several trips carrying in small amounts at a time. The seal coat is applied over the entire surface and as soon as the gravel has been spread the roadway is ready to carry traffic.

Blading or dragging of this surface mixes the gravel and tar and with the aid of traffic a uniform surface is obtained. Dragging or mixing is carried on until the surface "sets up." This usually requires three or four days.

Any weak spots or breaks, developing after the blading is discontinued, are immediately patched with premixed material using the same grade of tar and gravel as that used in the treatment. This maintenance must be done consistently and conscientiously or the quality of the surface will be greatly impaired. In fact bituminous treatments should not be attempted unless an experienced well equipped maintenance organization is on hand to handle the work.

If waviness develops after the tar sets up, the corrugations can be removed by cutting or planing the ridges

with a large blade, set at an angle of 45°. This operation is best performed on a hot day.

A road thus constructed costs about $1,500 to $1,800 per mile for a 24 ft. treated surface for the first year. This includes cost of gravel and application.

The second year treatment consists of a light application of tar of about two-tenths to twenty-five hundredths gallons per square yard and covered with 125 to 150 cu. yd. of gravel per mile. This treatment costs about $750 per mile. In a good many cases no treatment outside of patching is required during the third year, unless the traffic has been over 1,500 vehicles per day.

If the road does become unduly wavy or rough it has been demonstrated that the surface can be scarified and reshaped at a small cost.

Specification for Tar and Road Oil.—Below are the specifications of tar used for the above treatment, and also the specifications for the asphaltic road oil when that material is used:

Tar

The refined tar shall be homogeneous and meet the following requirements:

Water by weight, not more than, (per cent)	2.0
Specific Viscosity, Engler, 50 c.c. at 40°C.	8 to 15
Total Bitumen (Soluble in Carbon Disulphide) not less than, (per cent)	88
Distillation test on Water Free Material—	
Total Distillate by Weight, not more than,	
0 to 170°C., (per cent)	7
0 to 270°C., (per cent)	32
0 to 300°C., (per cent)	42
Softening Point of Residue, not more than, (°C.0)	60

Road Oil "B"

The road oil shall be homogeneous, free from water, shall not foam when heated to 120° C. (248°F.), and shall meet the following requirements:

Per cent Residue and 100 penetration	Specific Viscosity at 60°C.
40 — 50	3 — 12
40 — 60	10 — 20
60 — 75	10 — 25
Ductility of Residue, not less than, (Cm.)	50
Specific Gravity 25°C./25°C.	0.935 — 0.980
Total Bitumen (Soluble in Carbon Disulphide), not less than, (per cent)	99.5
Total Bitumen Insoluble in 86° B. Naphtha, not less than, (per cent)	12.0
Flash Point, (°C.)	45 — 90
Loss at 163°C., 50 gms., 5 hrs., (per cent)	12 — 27

Subgrade Treatment with Road Oil.—In 1925 due to the evidence of diminishing supply of gravel and also the inherent characteristic of certain subsoils to "eat up" gravel, experiments on gumbo and clay were tried hoping to waterproof the grade in order to hold the gravel up and the water out. It was hoped that gravel consumption could be reduced and the road made more serviceable during all seasons of the year. Especially in the gumbo, during the spring and fall, the consumption of gravel is extremely high with no apparent increase in stability of surface. The rains and spring "break-ups" render these roads as muddy, sticky and rutted thoroughfares requiring an unlimited expenditure of funds to get traffic through.

The first attempt toward the solution of this problem was the use of a road oil applied in two applications of about three-tenths of a gallon each per square yard. This oil was not covered with gravel and difficulties were encountered which discounted the method but the mere fact that the oil did waterproof the road and did stiffen or toughen the crust encouraged the Department to go further. The outstanding difficulties of the foreging process was the inability of preventing the "picking up" of the oil and more especially by steel tired vehicles. These roads are in rural communities and the latter class of vehicles are numerous. Then, too, the surface of a road which is oiled and not covered with gravel develops a slippery surface which introduces a hazard, especially in wet weather. It might be stated here that the gravel takes a great deal of the wear of traffic. The cost of patching and maintenance is higher on this type of surface and scarifying has to be done more frequently which again requires more oil.

At the same time that the above experiment was being carried on, several other experiments on clay and gumbo were tried using varying amounts of oil and gravel for covering material. Results were encouraging and the following year oiling subgrades on a large scale was started.

Method of Treatment.—The roadway to be treated is first allowed to take traffic for some time thereby bringing out the weak spots in the road. These defective areas, sags or pockets of non-uniform material, are filled with the prevailing clay or gumbo, and the roadway is then subjected to intensive blading or planing to develop a very smooth surface. The ability of this class of soil to pack and harden soon has the roadway in a uniform, smooth, and fast surface. While this operation is in progress, gravel is wind-rowed along one shoulder of the road at a rate of 350 to 450 yd. to the mile ready to be bladed over when the oil is applied.

When the road is shaped and dry (the latter cannot be emphasized too strongly) the application of oil is started.

Half of the roadway is treated first the material will absorb. This usually is between thirty-five hundredths and fifty-five hundredths gallons per square with a prime coat of as much oil as yard. It is applied with a power distributor at a temperature of 175°F. to 200°F. When this oil has driven in so that it will not pick up, traffic is allowed to use this side of the road and the prime coat applied on the other.

After the entire roadway has received the prime coat and is dry a seal coat is applied starting on the side of the road first primed, which is also the side on which the gravel is wind-rowed. The application of the seal coat can be at a lower temperature, about 160°F., and at the rate of three-tenths to thirty-five hundredths gallons per square yard. As soon as the seal coat is applied or within half an hour afterward a power patrol equipped with rubber tires and a 12 ft. blade pulls the gravel over the oiled surface. The entire surface is covered in this manner and the roadway is then ready to carry traffic which benefits the treatment without inconveniencing anyone. Some of the gravel is driven into the grade and also mixed with the oil but a thin layer of gravel is kept floating over this treatment and with the exception of a slight discoloration, exhibits all the characteristics of a good gravel road.

Maintenance on this type of road consisting of blading and planing is started at once and carried on systematically. However, the patrol sections are lengthened and one patrolman can successfully handle 20 miles instead of 6 to 10 miles of the gravel road. In some cases power patrols are used but in most cases spring blades mounted on trucks are found very satisfactory with the occaional use of supplementary equipment.

Second Year Treatment.—During the second year the roadway is bladed free from loose material and a light application of the same kind of oil used the first year is applied at the rate of two-tenths to three-tenths gallons per square yard. This is again covered with a thin coat of gravel. About 125 to 150 yd. to the mile of additional gravel is needed as a cover coat.

In places where break-ups have occurred or where extreme roughness is in evidence a light scarifying will remedy the difficulty with little additional cost.

The cost of this treatment ranges between $1,200 and $1,800 per mile the first year and half that amount the second year. In some cases the third year can go without any treatment, but it is usually advisable to repeat the second year treatment.

Specifications for Road Oil "A."—The road oil shall be homogeneous, free from water, shall not foam when heated to 120°C. (248°F.), and shall meet the following requirements.

Per cent Residue and 100 Penetration	Specific Viscosity at 60°C.
40 — 50	2 — 10
50 — 60	7 — 20
60 — 70	10 — 25
70 — 80	15 — 40
Ductility of Residue, not less than, (Cm.)	50
Specific Gravity 25°C./25°C., not less than	0.975
Total Bitumen (Soluble in Carbon Disulphide), not less than, (per cent)	99.5
Total Bitumen Insoluble in 86° B. Naphtha, not less than, (per cent)	9.0
Flash Point, not less than, (°C.)	90
Loss at 163°C., 50 gms., 5 hrs., not more than, (per cent)	6.0

Conclusions and Observations.—For the class of road developed it is cheaper and more expedient to treat clay and gumbo subgrades with oil before the application of gravel if the gravel has to be hauled any distance or if the subgrade possesses the inherent characteristic of "eating up" the gravel without giving any stability to the surface.

The dust hazard is practically eliminated, making traveling more pleasant and safe for the riding public, to say nothing of the relief that property owners and people among the highways experience.

Maintenance costs are reduced by the saving of replacement gravel and also the lengthening of patrol sections. One patrolman and helper can easily take

care of 20 to 25 miles of bituminous treated road instead of the 6 to 8 miles of dirt or gravel road.

A more serviceable road for all seasons of the year is developed. Storm water does not soak into the road surface.

Bituminous treated roads can carry economically a larger number of vehicles than an untreated surface.

In Minnesota the average daily vehicle census on bitumious treated roads was 1,275. The heaviest traveled road in the state was a bituminous treated road carrying an average of over 6,000 vehicles daily. From statistics compiled in Minnesota for 1926 the economical maximum limit for gravel roads was 587 cars per day and all of the bituminous roads are carrying well over this number without showing signs of distress.

In the use of bituminous materials you are putting something into the road that will not decrease in value as time goes on and subsequent treatments are made. This statement may seem axiomatic but the oil or tar help to build up a foundation suitable for heavier treatments, waterproofing and stabilizing the crust more with each succesesive treatment.

Gravel and Macadam Maintenance

Methods Used in Virginia County Described in Report at Convention American Road Builders Association

By W. W. SHIELDS
Superintendent of Roads, Staunton, Va.

THE maintenance of a gravel road will vary as the class of gravel used in its construction varies and to a certain degree the equipment will vary. In the mountain sections where the percentage of loam is very low in the creek bed gravel deposits, we find patching depressions from truck or wagon with a light road machine to smooth the surface, most economical. Continuous road machining tends to break the bond in these roads and keeps the surface, especially the center, covered with large gravel and stone. We find it takes these roads three years to completely bond and we believe the equipment needed then, provided the traffic is equal to 200 vehicles or more per 12 hour day, is an oil distributor and the necessary equipment for surface treatment. In the sections where the percentage of loam is greater, light scarifying with continuous use of road machine until the bond is perfected and then if the traffic is heavy enough the oil distributor and resufacing equipment.

In order to cover the subject of equipment for maintenance of a county system of macadam roads, I would place the work in the following divisions, namely:

Ditching and shouldering.
Patching.
Surface treatment.

In ditching we find that the use of a one-man power grader with an 8 ft. blade, is economical. This grader is usced to pull material from the ditches and sides of cuts to the shoulders and the excess material onto the edge of the macadam, where it is economically loaded by labor into trucks. Equipment needed is one power grader unit and with two trucks with 2 or 3 yd. capacity dump body.

In the patching of the surface of a county system of oil treated and penetration macadam roads, we feel that the gang patrol system can be used with the greatest efficiency, this gang patrol consisting of the following: Foreman in charge, six laborers and three truck drivers. Equipment needed: Two 3-ton dump body trucks for hauling stone and oil, one smaller truck for pulling maintenance heater and hauling men to and from job and one maintenance heater, capacity of 160 gal., mounted on 4-wheel chassis. The gang patrol would work as follows: Three men filling depression in front from the rear of a large truck; one man firing and drawing oil; one man pouring oil and one man sweeping the loose rock back into the oil. Hand brooms should be used for cleaning the surface of the road. We have used the single patrol on some of our better type of roads but have gone back to the gang patrol on account of economy.

The above described gang patrol and equipment should cover approximately 125 to 150 miles of 12 ft. road three or four times during a year, being off duty during the resurfacing season. It being economical to shift the gang patrol from patching to resurfacing and vice versa, during the resurfacing season. We use one central garage and oil depot and cover roads within a radius of 15 miles, using crushing plants within six miles of each other. We use three crushing plants to supply this gang patrol and buy 50 per cent of our stone from local crushing plants, this being done on account of the short haul and amount of stone needed.

The practice of having a central mixing plant is growing, and the extra equipment requirements are small—namely, a mixer suitable for mixing patching material with store bins.

We use the following equipment on our resurfacing work: Three crushing plants with proper grading revolving screen, one air compressor mounted on a small truck, four 3-ton dump trucks and four smaller trucks; all used in spotting rock and keeping the crushing plants going. Rock loaders are necessary and economical. We use a 500 gal. oil distributor mounted on a 3½-ton truck chassis and resurface from 30 to 40 miles of 12 ft. road per season. One 10-ton roller to follow close on resurfacing work is positively necessary, and where more than one or two cars are applied continuously, two rollers are required to get satisfactory results.

The about 150 miles of road carries a varying traffic of 200 to 400 vehicles per 12-hour day.

Allis-Chalmers Buys Monarch Tractors

The Monarch Tractors Corporation of Springfield, Ill., was recently purchased by the Allis-Chalmers Manufacturing Company of Milwaukee, Wis.

Announcement of the merger was made on February 27th by Gen. Otto H. Falk, president of the Allis-Chalmers Manufacturing Company, following negotiations which had been under way for several weeks and which were completed on February 27th at a meeting in Chicago of officials of the two companies.

Extensive investigations were made by executives of the Milwaukee Company of the track-type tractor industry, and specifically of the Monarch Tractor. As a result of this investigation, the Monarch business was purchased outright. Manufacturing operations will continue at the Monarch plant in Springfield.

In acquring the Monarch business, Allis-Chalmers obtains the valuable patent rights under which Monarch tractors have been built, and the Monarch organization gains the Allis-Chalmers background with the opportunities it offers for executive, purchasing and manufacturing economies, as well as a tremendous sales organization of branches and agencies throughout the world.

While all details have not been announced, it is reported that the sum of $500,000 was involved in the transaction.

No changes are contemplated in the Monarch executive factory organizations, R. W. Gotshall continuing as president, and H. B. Baker as sales manager.

It is stated that arrangements have been made to install additional machinery and equipment to provide a considerable increase in tractor production.

Monarch Tractors Corporation was organized in January, 1926, as an Illinois corporation, and took over the business formerly located at Watertown, Wis. R. W. Gotshall and H. B. Baker, formerly executives of the Holt Manufacturing Company of Peoria, Ill., for a number of years, acquired the management of the Wisconsin company and arranged for its removal to Springfield. New model tractors were put in production in June, 1926. Several hundred tractors of ten ton and six ton sizes have been built. The company did a volume of business in excess of $1,250,000 during 1927.

Making Precast Concrete Handrails for Highway Bridges

Details of Precast Bridge Units Given in British Magazine

By F. BURREN

IN "Concrete for the Builder and Concrete Products," an English journal, the following information was given for the bridge builder.

The shape of handrail shown has been specially selected because of the simplicity of making the necessary molds compared with round units. At the same time this shape looks well, and is frequently used for bridge parapets, etc.

Making Molds. — The method of making molds for balusters, base, and coping is clearly shown in the dimensioned drawings.

The mold for the baluster is perhaps more difficult to make than those for the coping and base, but if care is taken with the mitres (as shown in plan D) and the forms worked true, no great difficulty should occur when stripping this mold.

The side forms of the molds for the coping and base are more simple to make if built with sections as shown at (G) and (H).

Great care should be taken when making such molds to ensure that the wood is free from warping.

The mold for the baluster is designed for the baluster to be cast perpendicular; having the forms tongued at the angles will ensure the mold keeping square

Stripping.—To strip this mold it is advisable to lay the mold flat on one of the sides that are tongued. The base can be taken away, followed by the two side forms which are grooved, and then the third side, which will be at the top.

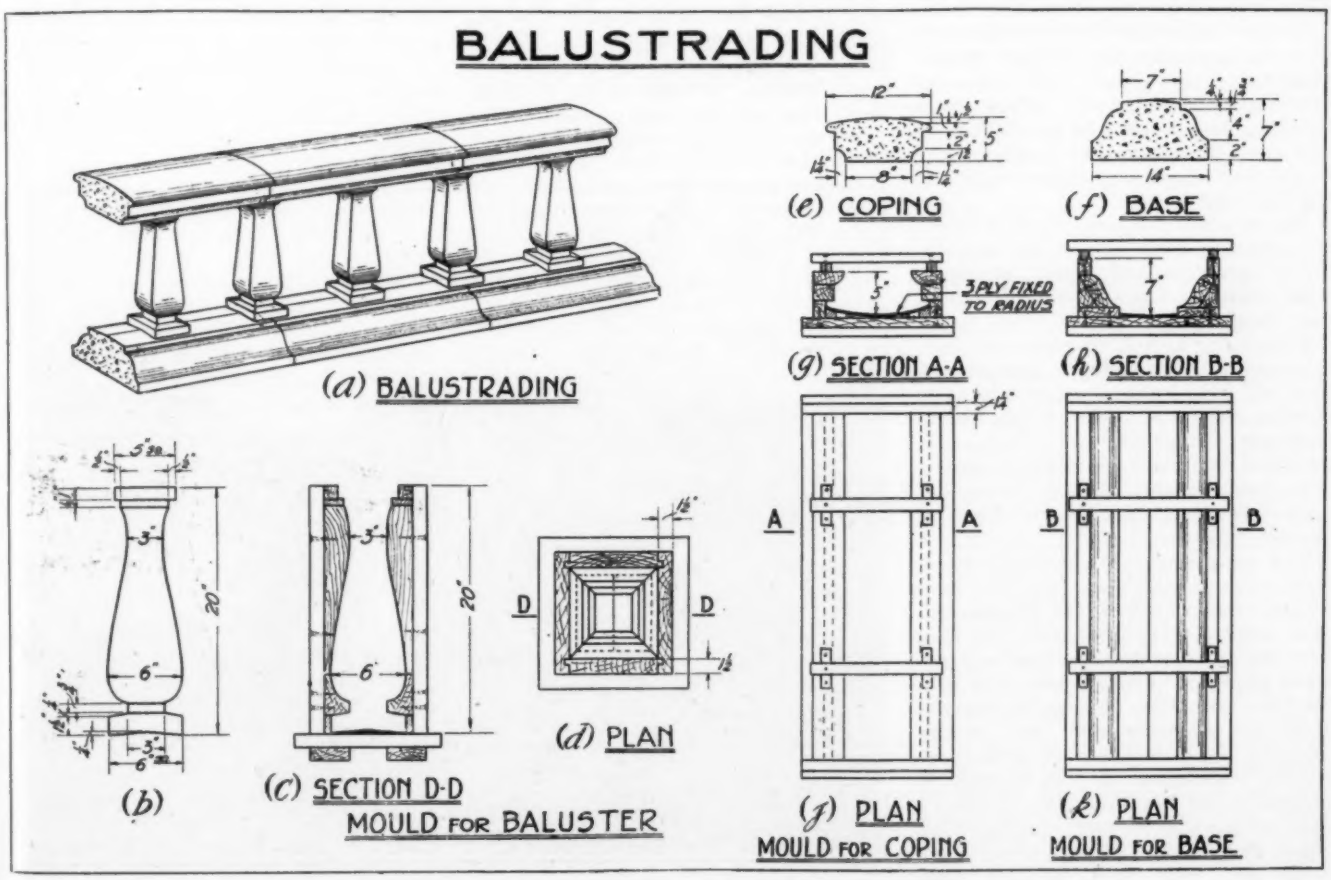
Following these operations, a pallet board should be placed upon the baluster. Then completely turn the baluster, so that the remaining side form can be taken away, leaving the baluster upon the pallet board.

The stripping of the molds for the coping and base is done by turning the molds and casting upside down, taking the bases away, and withdrawing the end and side forms.

Care of Molds.—Ordinary form lumber is quite suitable for making these molds, and if worked true it will give excellent results. (Cypress would give best results.)

It is advisable to soak the molds in water when first made and allow them to "surface-dry" before being used. Should the molds stand idle for any length of time they should be soaked again before using.

The molds should be cleaned each time before being used, and treated with form oil or a damp paraffin rag to prevent the concrete from adhering to the forms.



Details of Forms Required to Cast the Handrail Described

Materials.—Such products can be made in any color to match natural stone; this is governed by the color of the aggregates and adding coloring matter to the cement.

Good results should be obtained for the coping and base by the following mix:

4 parts ⅜-in. to ⅛-in. granite or other coarse aggregate.

2 parts clean washed sand.

1 part Portland cement.

The baluster should be made with:

4 parts ¼-in. to ⅛-in. coarse aggregate.

2 parts clean washed sand.

1 part Portland cement.

Reinforcement.—It is not necessary to reinforce the coping and base, but it is advisable to place one ¼-in. diameter bar as reinforcement in the baluster placed centrally and hooked at each end.

Autocar Develops New Truck for Road Builders

At the National Good Roads Show in Cleveland, held during the second week in January, the Autocar Company of Ardmore, Pa., exhibited a three-ton, six-cylinder road contractor's truck, appropriately named the "Trail Blazer" which, it is claimed, is the most modern and scientifically efficient piece of motor equipment ever provided for the contracting trade.

The Autocar Company have been in close contact with road-building problems ever since the motor truck came into existence in this country thirty years ago and have had engineers studying the highway construction problem with a view to providiing, at any cost, the truck that in every way would best meet the requirements of the industry.

The result is the new "Trail Blazer," a campanion truck to the four-cylinder HPDS, but designed to work efficiently under the worst possible conditions of road construction.

The engine is located under the driver's seat, thus providing a short wheelbase of 114 inches, which means a turning circle only thirty-eight feet in diameter. This short wheelbase is an exclusive feature, not obtainable in any other truck except where the frame has been sawed off at the sacrifice of chassis balance.

The six-cylinder engine provides a torque curve which flattens out in a more sustained plateau of steadily applied power. This new engine has been provided to meet the exceptionally adverse conditions under which road contractors are often obliged to operate. They are pioneers and their trucks must go where trucks have never been before, regardless of the terrain, in preparing the highways over which so much of the nation's business is carried. Sand and mud, steep grades, heavy loads and long pulls are all made easier by a six-cylinder engine.

Contracting calls for a transportation unit that will go through sand and mud without danger to the important parts. The "Trail Blazer" has provided for this in the full-floating rear axle, cased in a dirt-proof housing, so constructed that all gears and bearings can be adjusted or lubricated without jacking, removing the wheel or disturbing the load.

General View of the New Autocar Truck That Was Designed for the Paving Contractor. It Has a Remarkably Short Turning Radius

The frame of this truck, a part that receives greater abuse in the contracting and road building trade than any other part, is made of chrome nickel pressed steel, especially heat treated at the Autocar Factory.

Special Truckcrane Assembled for Setting Light Poles

The City of Milwaukee, in order to carry out a program of installing a large number of ornamental lighting standards, has devised an interesting outfit that promises to reduce handling costs. This equipment consists of a standard Bay City Tractor Crane assembly, without tractor power unit or crawlers, mounted on the chassis of a Sterling 5-ton motor truck.

The machine is essentially the upper framework and the machinery assembly of the Bay City machine, from which the crawler mounting, the car body, and the tractor power unit have been eliminated. This crane unit has been mounted on the motor truck. The power for driving the truck and for operating the crane machinery is furnished by the truck motor through a special power takeoff to the crane machinery.

This equipment was purchased by the Public Works Department of the City of Milwaukee, Wisconsin, for handling and setting in position a large quantity of concrete electric lighting poles in connection with several miles of whiteway system. The machine has been delivered and put into operation.

The photograph shows the crane being used for stock-piling the standards in the yard, with a simple sling hitch and a number of men. The same crane will be used in setting the poles throughout the project.

The truck was sold to the City by the Sterling Motor Truck Company, of Milwaukee, and the crane was manufactured and mounted to special order by the Bay City Dredge Works, of Bay City, Michigan. The latter company states that while it does not intend to go into the truck-crane business or otherwise depart from their present line of material handling equipment, yet they are prepared to furnish duplicates of this oufit to any community upon special order.

The Bay City Crane Mounted on Sterling 5-Ton Motor Truck Now Being Used by the City of Milwaukee for Handling and Setting Ornamental Lighting Standards

Field Control of Pavement Concrete

Paper Presented at 1928 Michigan Conference on Highway Engineering

By H. S. MATTIMORE
Engineer of Tests, Pennsylvania State Highway Department

THE main factors controlling the service value of a concrete pavement are design and concrete quality. These factors are interdependable, as the design is based on the strength of concrete slab; therefore, providing due consideration is given to anticipated traffic loads and subgrade foundations, the efficiency of the road slab is governed by concrete quality.

The quality of the concrete in the finished surfacing depends upon the quality and quantity of cement, fine and coarse aggregate, methods used in proportioning, time of mix, quantity of water used, methods of placing, methods used in finishing, and methods and duration of curing and protection. A neglect in the supervision and inspection of any of these operations has at least an affect on the ultimate maintenance cost and service value of the road surface, and way, under certain conditions, be a direct cause of failure.

Materials.—Most engineers now realize that the quality of materials used in their concrete has a considerable bearing on the efficiency of the finished structure. This has resulted in better material specifications, and, in most of the larger organizations, in the organization of a laboratory, for the testing of materials. Usually we find that the specifications and methods of tests are well provided for, but the field control of the materials is still at its early stage of advancement. Efficient specifications, and the ascertaining of quality by preliminary testing, are essential provisions, but unless the organization is perfected so as to fully control the quality of materials being used, the specifications and testing lose a large part of their value. Many highway departments are realizing this and have organized and trained engineers to control this phase of inspection.

Material Inspection.—The place at which materials are to be controlled depends mainly on geographic situation. Some highway departments have found it economical and satisfactory to establish inspection at the material plant. Where materials are segregated, this may be the proper procedure, but in some other sections where material sources are scattered and many small producers exist, this method is not only expensive, but likely to be inefficient if plant inspectors are not of a high type and closely supervised. Further, I do not believe that any organization responsible for the supervision of pavement construction, can guarantee a final inspection of aggregate at the source. Even assuming that efficient inspection is maintained at the source, it is possible for aggregates to get segregated in sizes or to become contaminated with harmful materials during loading and handling.

Inspection at destination has been found to work efficiently in some states. In some of these locations I have found that the most successful method of control is what may be considered combination of inspection at the source and destination. Under this plan, where the amount of shipments warrant it, cement for which no method of field testing is feasible, should be inspected at the source. This can be stored in assigned bins under seal, and shipments made under the supervision of the inspector. So far as concrete aggregates are concerned, inexpensive field equipment for the testing of grading, organic content, and silt are available. In order to have such a system work successfully, the following plan should be followed:

Preliminary inspection must be made of material sources prior to approving the product. Second—subsequent periodic inspections must be made at all aggregate plants; such periods to be regulated by the quality of the material received from the different plants. Third—provisions must be made to thoroughly train the inspector who is responsible for the sampling and testing of the material at the destination.

This latter provision can be accomplished by holding brief courses on materials within the organization itself, or at some university, and to follow this up by having material inspectors travel from the material division. The duty of these inspectors is to visit various contracts to instruct the contract plant inspector in sampling and field testing of materials, and make periodic inspections at material sources. These men should submit frequent reports to the Materials Division relative to the condition on the various contracts and material plants which they visit.

Proportioning.—The proportions of cement and aggregates, and the detail methods used for gauging them, have a major effect in the efficiency and durability of a concrete road slab. During the past four or five years, several methods for the ideal proportioning or, as they are termed, "the design of concrete mixes," have been given considerable publicity. Some of these methods in practice have been reported to be economical, and at the same time resulting in a concrete of the desired strength. To date I do not know of any practical method for the utilization of these designs in concrete roadwork of any magnitude. Usually they require change in proportioning where the materials vary in gradation, also preliminary experiments have to be made on coarse and fine aggregates that are to be used on the work. This presents difficulties where the work is let by contract, from the standpoint that the general quality of material can be specified, but the actual source is not always known. And, unless definite material data can be given, a contractor would have difficulty in preparing an estimate. Therefore, although the arbitrary mixes, as used, may not be ideal, they are more easily controlled and better fit the conditions in a large highway construction program.

As a result of investigations in the laboratory and field, many highway departments are giving consideration to the proportioning of aggregates by weight. This has many advantages over the customary volumetric proportioning, especially for the fine aggregate. Published data are available, demonstrating that more uniform strengths are obtained with this method of proportioning. After considerable investigation, the Committee on Character and Use of Road Materials of the Highway Research Board in their report of 1926, recommends that concrete aggregates should be proportioned by weight. This is further emphasized in the 1927 report. The American Association of State Highway Officials has submitted a report from one of their committees, through letter ballot, to different states recommending that the weight proportioning of concrete aggregates be adopted as a standard, and the probabilities are that many highway departments will adopt this method of proportioning as a standard within the next two years.

The time of mix, and the quantity of water used in the mix, have been so thoroughly discussed during the past several years that I believe most highway engineers are educated to the point where they fully realize that these are operations which should be care-

fully supervised. The tendency for increased production on the part of operators may at times cause an inclination to speed up the time of mix, and favor a wetter mix to facilitate handling.

Placing.—Careless methods of placing concrete in pavement may lead to segregation, porosity, and thin slab depth. Lack of inspection at the stage of the operation may have a serious effect on the strength of the slab. In modern practice, where from 800 to 1,000 ft. of concrete road slab has been laid in a day, an inspector has to be alert to assure himself that the proper depth of concrete is being laid throughout the section. Subgrade testers, if properly used, would detect a shortage of depth on the main part of the subgrade, but additional precautions must be observed to have any excess of material removed which has accumulated near the forms so that the full height of the form is exposed.

Finishing.—Probably there has been more changes in methods of finishing of concrete pavement than any other operation. In this connection, the hand and mechanical screed are the usual specified preliminary steps, followed by belting, rolling and floating. It may not be possible to standardize these operations, as there are probabilities of certain methods of finishing being adaptable to certain concrete mixes, but regardless of what methods are used in the finishing, precautions should be taken to avoid overfinishing. The demand for smooth riding surfaces may lead to such over-finishing with its resulting evils, the most serious of which is a scaled surface. Probably one of the tools which is responsible for more over-finishing than any other, is the long handled float. This is apparently a desirable occupation for the workman, and I have found in many cases that it is a difficult one to control.

Curing.—There is probably no other concrete structure which is constructed under the severe conditions as the concrete road slab. We have data on file of the construction of the concrete highway in which the water was pumped from five to six miles, the materials were hauled ten miles, and the temperature during part of the day was 100 degrees with low humidity. Test of the temperature of the water showed it to be close to 100 degrees. Under such conditions, a concrete road slab has very little opportunity to develop essential characteristics, except special precautions are taken in prompt and efficient curing. On the project I refer to, it was found necessary to thoroughly saturate the aggregates in the stockpile, and to apply a double thickness of saturated burlap at an early stage after finishing, in order to avoid hair checking.

Our investigation of the cause of hair checking has lead us to definitely conclude that it is caused by a rapid dehydration of the concrete, therefore, the logical cure is to prevent this rapid dehydration by applying water at the proper time. I might say that the proper time and place to apply this water is not in the mixer, as excess water at that period not only causes a segregation in the mix, but probably aggravates rather than cures the condition. Do not treat this hair checking as a slight defect by drilling into road slabs; we have found these checks in some cases to extend through half the depth of a 7 in. slab. It is possible to correct this condition, and in cases where proper precautions are taken, it was practically eliminated.

General Inspection.—Careless work, such as too wet a consistency and improper mixing, careless placing, overfinishing of the surface, improper placing of expansion joints, poor alignment of the center line joint, and non-uniformity in subgrade depth, are conditions which have been great factors in causing highway surfaces to be unsatisfactory where conditions have showed the design and material used were excellent for the purpose. These apparent minor details of inspection may be the major factors in the ultimate results obtained. Many comparative examples can be cited in different sections where highway surfacing built under almost identical specifications and of the same design, in one case is practically a failure, and in another an excellent example of durable construction. This difference in results can be almost entirely attributed to the quality and kind of inspection. Some defects that may occur in a concrete road slab which can be eliminated or at least remedied by efficient inspection are: Surface scale, many cases of which have been traced to late finishing, over-finishing, or an excess of fines in the sand. Porosity, due either to concrete of too wet a consistency or improper placing. Excessively dry concrete may be porous, if not properly placed, but the usual fault is to have concrete too wet rather than too dry. Spalling at expansion joints due to improper alignment or improper placing of joints. Care to secure proper alignment and rigidity by proper staking will eliminate this trouble. Spalling or shearing at edge of pavement at expansion joint. This occurs where the expansion joint material does not extend clear through to the edge of the pavement, and the remedy is to inspect this condition and where necessary cut the joint through at the edge.

Weak, unreliable, inefficient inspectors are a factor in producing poor results, while efficient work on the part of the inspector can be observed in many excellent samples of concrete highways in various part of the United States. Another factor that cannot be too forcibly presented to the inspector is that the majority of good specifications written at the present day are the result of past experience and practice. The idea is writing these specifications is to give an accurate guide to the contractor and inspector, and in cases where specifications are practicable intelligent ones, they must be followed practically to the letter. In cases where impracticable, indefinite specifications, exist, the only remedy is to rewrite them before the contract is let and the work proceeded with. In other words, it is my opinion that no inspector should have the privilege to change specifications requirements on major items. If such a condition exist you can readily see where we can establish as many standards as we have inspectors employed.

Tests on Finished Concrete.—As important provision for field control of pavement concrete is the sampling and testing of finished product. If properly controlled, the results of these tests should give considerable information, relative to the aggregates used, proportioning, efficiency of mix, etc. Until the past few years, the practice has been to depend entirely upon compression tests on cylinders made, and usually stored in the field and tested in the laboratory. The new thickened edge road slab, the design of which is based on modulus of rupture, computed from the transverse tests, has revived interest in this latter test to an extent where it is rapidly replacing the compression tests for the control of pavement concrete.

The logical assumption that the stress applied to the test specimens should have a definite relation to the stresses used as a basis for design of the structure, justifies adoption of the transverse tests. Further, this test has been found to be especially applicable to field control, as it can be made at the site of the work by inexpensive equipment, thereby eliminating expenses and delays of shipping to the laboratory. These advantages taken into account with published data, showing more concordant results on the transverse than the compression tests, are responsible for the favor with which this test is being received.

All organizations supervising concrete pavement construction should make tests on specimens moulded from concrete placed in the road slab. In order that the results of such tests will be indicative of the strength of the concrete in the road surface, great precautions should be taken to have the men who make the specimens, and perform the tests, thoroughly trained. In our organization, inspectors from the materilas division are responsible for training the engineers and inspectors from the construction division along this line. The concrete for the test specimens is taken after the material is dumped and placed on the road surface. Several other methods were tried, such as dumping directly into a container, etc., but the method of sampling from the material in place gave more uniform results. The specimens are cured in the same manner as the pavement.

You will note that practically all our

field tests are performed at destination by construction engineers and inspectors. The aggregate testing is handled by plant inspectors assigned to the central proportioning plant at the material delivery site. The transverse concrete test is also carried on here, but is under the supervision of an assistant engineer of construtcion. This method of control has worked satisfactorily in our organization. If any one point should be selected as of the utmost importance in this method of control, it would be the thorough training of the inspector responsible for the sampling and field testing and detailed supervision by traveling inspectors from the Material Division.

Our experience has been that the inspection of aggregates at destination has lead the producer to realize his responsibility in the quality of material shipped. Many of these producers have assigned their own inspectors to the sampling and testing of materials prior to shipment.

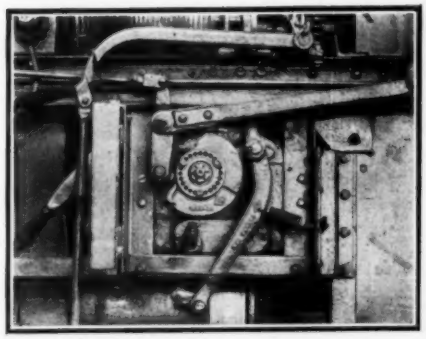
New Mechanical Man Saves 2,000 Operations

One of the interesting developments on pavers this year is contributed by the Chain Belt Company, Milwaukee, in the form of a "Mechanical Man" on the 1928 Rex Paver. Thousands of dollars in money and nearly three years in experimental work was spent in supplying this automatic high-speed principle to the Rex Paver. The result is accomplished by a very simple mechanism. Three cams and three levers—connected to the skip hoist, the water valves, and the discharge chute—perform all operations with sureness and accuracy. It works on the simple principle used in all automatic machinery which performs thousands of operations daily without attention and without delay. In a day's run the Rex operator is relieved of over 2,000 manual operations. But if desired, any or all of the present operations can be performed independently of the Rex Mechanical Man. This means that if for any reason the entire Mechanical Man mechanism failed, the operator could go ahead without a stop and operate the paver manually. And by a simple adjustment of the three Mechanical Man cams, the automatic timing of all operations can be varied. The Rex Mechanical Man was perfected and ready for the market in 1926, but because of its great importance another full year was taken for field tests. During 1927 it was tried out under actual working conditions in all parts of the country. The work it performed was compared with pavers operated manually. As a result, the advantages of the Rex Mechanical Man—which is simply automatic high-speed paver operation—can be definitely stated in seconds saved on every batch, in increased yardage per hour, and in dollars and cents per day.

The dribble in discharging occurs at the last end of the batch. It results in the separation of concrete which is noticeable when discharging the last few feet of concrete from the drum. Shutting off the discharge at the end of the 8 or 10 seconds eliminates this dribble and prevents the separation of the fine and coarse aggregates at the last end of the discharge.

The reason for this is as follows: When discharging the entire batch, the discharge buckets cut through a large homogeneous mass of concrete during the first few seconds of the discharge period—during this period they pick and carry their full capacity—but during the last part of the discharge period there is a gradual tapering off of the amount of concrete in the drum which the buckets can pick up. This results in a gradual slowing up and a dribble and separation of concrete in the discharge of the last part of the batch, when attempting to discharge all of the concrete from the drum. It is one of the most noticeable faults of manual operation.

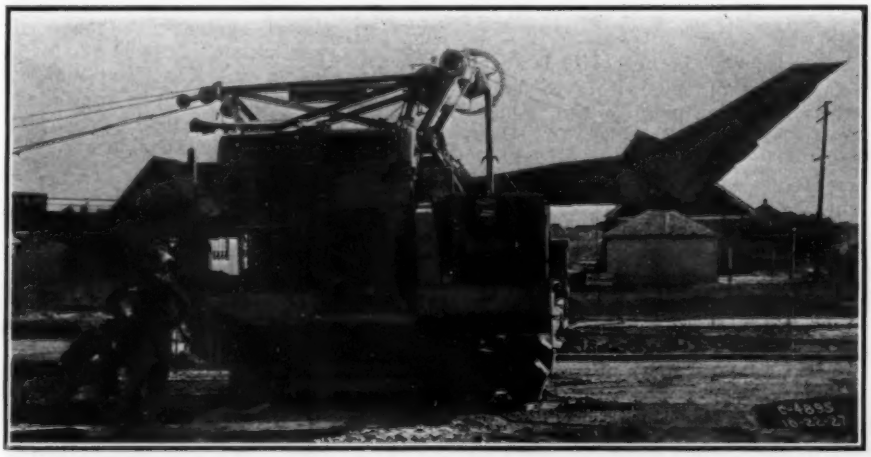
The Rex Mechanical Man regulates and controls the discharging action. It discharges full batches of uniformly mixed concrete in 8 seconds by automatically shutting off the discharge at the end of a fixed period, and carrying over a constant amount of concrete into the next batch.



Closeup of Mechanical Man Now Installed on Rex Pavers

Field tests show that the action of the Rex Mechanical Man in shutting off the discharge in 8 seconds insures the discharge of a fixed amount of concrete equal to the amount which is added in each successive batch. In other words, the Rex automatic 8-second discharge clears the drum and prevents any accumulation or building up of the concrete in the drum beyond the amount normally carried over and remixed with each succeeding batch. This holds true when mixing any size batch which can be handled in the 27-E Rex, or when mixing the concrete to any desired consistency.

These field tests show that with sufficient concrete in the drum to permit the buckets to carry full during the entire discharge period, the Rex 27-E will discharge approximately 35 cubic feet of mixed concrete in 8 seconds, according to the manufacturers.



A Rex Paver Equipped with the Mechanical Man Saves Much Work on the Part of the Operator and Makes Automatic High Speed Operation Possible

Good Roads Congress to Be Held in Mexico

It has been announced that a Good Roads Congress will be held in Mexico City toward the end of 1928, according to a report from Acting Commercial Attache George Wythe to the Department of Commerce. The exact date has not yet been set. State governments and private organizations interested in the construction of good roads will be represented at the congress, in addition to the Federal Government.

The congress is being organized under the auspices of the Mexican National Highway Commission, with the co-operation of the Treasury Department and Department of Communications and Public Works. The purpose of the congress will be to co-ordinate the road building activities of the various states and to stimulate interest in the subject of good roads. It is proposed to hold an exhibition of road building machinery during the congress.

County Organization for Road Work

How Highway Construction and Maintenance Is Handled in Norfolk County, Virginia

By R. B. PRESTON

IN 1914 the better thinking business men of the county rose up and smote the "Ins" out. New members were sent to the legislature, a new judge was on the bench, new supervisors were in office and Norfolk County prepared to put its house in order.

Centralizing Authority.—A law was passed through the general assembly in Richmond, taking out of the hands of the supervisors all authority in connection with the construction, maintenance and control of the county highway system, with the end in view that authority should be centralized and responsibility properly placed. Under this law the court was empowered and directed to appoint a county road commission, and while there are six geographical districts in the county only three men constituted this commission, one of whom acts as chairman, another as secretary. In fact our commission was, and is, fashioned along absolutely parallel lines with our present state highway commission, and was so organized and appointed several years prior to the organization of that small cohesive body now representing the state, and headed by H. G. Shirley, whom Virginians consider the best. Then, after formal organization of the county commission, it appointed an engineer, and faced what appeared to be an almost insurmountable problem, with no funds available.

Financing the First Improvements.—It was obvious that the county could not at that time operate on a pay-as-you-go plan, because we had no roads built as a beginning of our system, and in order to get the people out of the mud quickly it was necessary, and we think good judgment, to secure funds promptly in order to construct our backbone roads so that the farmer could get his products to market, and the suburbanite could operate his automobile to town.

We considered the "mud tax" of a much more serious nature than the interest on bonds, and a small bond issue of $250,000 was authorized for the purpose of buying and re-building the toll roads of the county. However, we have now reached a point where we operate on practically the pay-as-you-go plan.

Incidently, these "toll roads" mentioned here were in an almost impassable condition, and the court had restrained the owners from charging any fee for the doubtful privilege of travelling them.

This first bond issue met considerable opposition before it was ratified, but ere it was entirely spent the people had begun to see the light, and an additional issue of $1,000,000 went over with hardly a dissenting vote, as others have done up to this date.

Our organization was, and is, the commission as above described—an engineer to the commission, two assistant engineers, with such further assistance in the way of survey parties, instrument men, inspectors, etc., as was compatible with the work in hand.

Maintenance Methods.—The county owned a long time lease on a stone quarry, and it was operated by the county largely with prison labor. It kept, and has now, several crews of men operating in trucks to look after maintenance, one, two or more crews looking to the maintenance of hard surfaces, another gang principally on bridge maintenance, and one in each district to operate road machines and drags to properly maintain the top soil or graded roads of the county.

We have not found the "patrol system" on maintenance successful here, owing to the fact that our county is so cut up by waterways, and also because, while the negro labor we have is good when properly directed, it is not responsible when on its own, so we find that small, fast moving maintenance crews, with a white foreman in charge, is very much to be preferred.

Besides owning its course of stone supply the county owns a considerable road equipment. We do all of our own surface treatments, and in cases, particularly during the war period, and just after, where we considered bids excessive on concrete, asphaltic macadam, surface treated macadam, etc., we assumed the contracts, and did the construction with our own forces, effecting considerable saving of funds to the county.

In this county organization we had a department to make surveys on state aid work, submit plans to the highway commission of the state, and when approved received credit for forthcoming state aid. However, in the past few years direct state aid has been discontinued in Virginia, and the counties receive a pro-rata share of tax levied as a state wide charge on gas.

In our county the authority is vested in the board of supervisors to fix the levy and secure funds for the "general county levy fund," which funds are turned over to, and disbursed by, the commission as described. The supervisors being in the nature of the producer of funds—the road commission the operator, or constructor. Happily the board of supervisors of the latter days and the road commission have, in the main, worked in harmony for the betterment of the county.

The clerical force of the commission is small but adequate. We have a bookkeeper and stenographer, the engineer attends to all correspondence, and between meetings the major portion of the administrative work of the commission. Each year the books and accounts of the commission are checked by a certified public accountant, who prepares a report, setting forth all the receipts and disbursements of the commission in the previous year, charging each road or bridge, by name or number, with funds allocated to it for construction and maintenance, which report is published in the newspapers of Norfolk and Portsmouth.

The County Road Organization.—Our organization in a nutshell consists of

Road Commission—three members at nominal salaries.

Office force—as described above.

Engineer—two assistants, and such additional engineering forces, off and on, as commensurate with the work.

Maintenance Crew—hard surfaces.

Surfacing Crew—with oiling equipment.

District Crews—on soil roads, drainage, etc.

Bridge Repair Crew—also employed in drainage installation.

Floating Crew—to cover emergencies, etc.

Repair Shop—one head mechanic and helpers to repair trucks, rollers, sweepers and other machinery, and to inspect, grease and keep in condition drawbridges in the county.

Eight Bridge Tenders — operating draw spans over navigable waters.

Result of Organization.—Placing the burden of responsibility upon a small body, the Commission, transmitting said responsibility on down through the engineer to his assistants, foremen, mechanics, etc., each with the responsibility of his own department.

Further results: An extremely low overhead, and, we hope work well done.

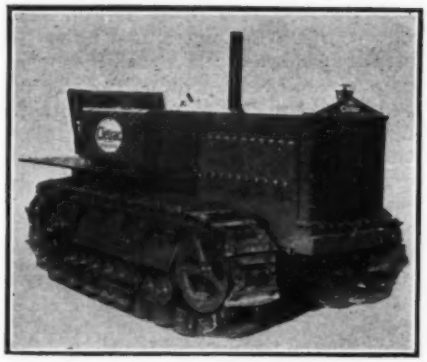
Anyway in 1914 not one mile of decent roadway existed in Norfolk County, while in 1927, we have approximately 300 miles of hard surfaced roads, the bridges are of concrete or heavy creosoted material, our taxes are reasonable, and our people are prosperous and happy.

We personally can take very little glory to ourselves. It is the result of "Organization." In 1914 a "horrible example"—In 1927 we are well on the way to a real system. A cohesive, earnest organization. That is all.

Acknowledgment.—The above matter is abstracted from a paper presented by Mr. Preston at the 1928 convention of the American Road Builders Association.

Cletrac 40 a New Tractor for Road Builders

The Cleveland Tractor Company, Cleveland, Ohio, has just added a new tractor to their complete line, to be known as Cletrac 40. It is powered with a six-clinder, four cycle, water cooled, valve-in-head motor with the cylinders cast en bloc, with 4½ in. bore and 5 in. stroke, manufactured of S. A. E. materials that assure the best of per-



The New Cletrac 40, a Tractor That Has Interesting Features

formance and long life. Lubrication to the crankshaft, connecting rods, cam shaft, and valve rocker shaft is by force feed, while lubrication of cylinder walls, pistons, rings, and piston pins is by the splash system. Delco Remy 12-volt starting, lighting, and ignition units are furnished as standard equipment, with a Willard 12-volt, 120 amp. hour battery. A Taco fly ball type governor is used in conjunction with hand control for increased motor speed.

A Kingston carburetor, with manifold hot spotted above, is standard equipment. The air supply to the carburetor is first cleaned by a Pomona cleaner. An adequate cooling system is provided. The clutch is of the Borg and Beck pull type, single plate, 14 in. in diameter. The transmission is of the selective type, with three speeds forward and one reverse. At an engine speed of 1,575 R. P. M. the low speed is 2.2 m. p. h., the intermediate speed is 3.6 m. p. h., and the high speed is 5.7 m. p. h., while the speed in reverse is 2 m. p. h.

Steering is accomplished by the effect of the motor through a planetary compensating differential. As pressure is applied to either side of the steering brake drums by the steering band, it slows down the respective track on the band to which the pressure is applied, causing the opposite track to speed up.

Eight lower track wheel assemblies, of the plain bearing design, having cast iron bearing boxes and hardened steel shafts, are lubricated by the "One Shot" force feed system. One press of the plunger will lubricate all the lower track wheel bearings, it is claimed. Five upper track wheel assemblies, of the same type of design as the lower assemblies and lubricated in the same manner, are provided.

The track shoes are 14 in. wide, 10 in. pitch, and grousers are 2½ in. high and 17 in. wide. Each track has a ground length of 80 in. and a tractive area of 2,240 sq. in., developing a ground pressure of 4.5 lb. per sq. in.

The overall length is 132 in., the overall width is 69 in., and the overall height is 63 in. The tracks are 48 in. center to center. The clearance at the drawbar spring is 8 in., without grousers. The turning radius is 11 ft. This tractor has a rating of 40 h. p. at the drawbar and 55 h. p. at the power pulley. A power takeoff pulley is supplied as extra equipment.

New American High-Speed Electric Hoist

The design of the new American High-Speed Electric Hoist is such that it is equally suited to bridge steel erection service, concrete tower work or general contractors' use, according to the manufacturers.

Made especially speedy, this new hoist has already helped large contractors to complete their work in what seemed an impossible time limit, it is said.

The American High-Speed Electric Hoist is of rugged construction with many features that go for long life. A few of these features are: shafts larger than the usual practice; drums machined after being cast to insure true, even pull and smooth movement of

The New American High-Speed Electric Hoist Designed to Cut Construction Time on Any Erection Job

loads; enclosed, silent chain drive running in oil; large diameter, smooth running, long service frictions; large, dependable, long wearing brakes and a "sure-fire" safety brake, mounted on the pinion shaft, never needs adjustment, the manufacturers state.

In moving from one job to another, it is necessary to be prepared for alternating or direct current. The new American High-Speed Hoist meets this situation by the use of Interchangeable electrical equipment. The ability to change from one type of current to another, proving a real convenience.

Further information on this High-Speed Electric Hoist is given in a booklet which can be had by writing to the American Hoist & Derrick Company, 63 South Robert Street, St. Paul, Minnesota.

Lessmann Loader Co. Has New Machines

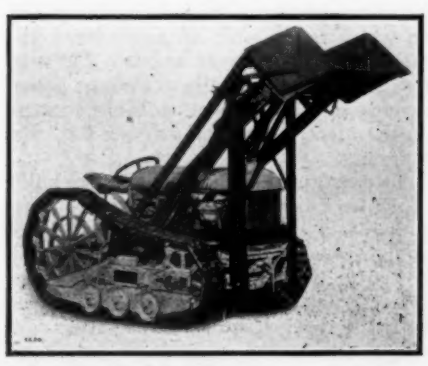
Of interest and importance to construction companies, contractors, public works officials, manufacturers, etc., is the announcement that the Lessmann Loader Company, Des Moines, Iowa, has put into production an improved high-lift loader and also an improved low-lift shovel.

This company has recently been completely re-organized, and with the introduction of the new capital some of the best engineering talent in the industry has been brought into consultation in improving the loader and shovel. The results have been some very important changes in the construction and materials used in both machines, so that the Lessmann Loader and the Lessmann Shovel are now as fool-proof as such equipment can be made.

Among the improvements is the substitution of steel for malleable iron in many of the parts, thus generally strengthening the machines. Other changes include an improved clutch, cable tighteners which insure even hoisting of the bucket, anti-friction bearings, and an extra-long pinion shaft bushing of highest grade bronze. The mechanical principle of the Lessmann Loader, which has thoroughly proved its efficiency and desirability, has been retained in the new loader and shovel, because it is the most logical and efficient method of operating a loading or digging device. This is attested by the fact that practically all big shovels, cranes, loaders, etc., are constructed on the same principle.

With the Lessmann the strain of lifting does not all come at the front of the tractor as is the case with most front-end attachments, but instead much of it comes at the pivot point of the lift, which in the case of the Lessmann, is at the center of the tractor, as may be seen in the illustration. This feature not only means less strain on the equipment, but also insures greater efficiency and better balance, and greatly reduces the tendency of the tractor to rock or pitch forward when the bucket is loaded.

The Lessmann-equipped Fordson is said to be an ideal unit for anyone who has excavating, loading, moving materials, spreading, etc., to do. Complete information will be sent on request by the Lessmann Loader Company, Des Moines, Iowa.



The Improved High-Lift Loader Announced by Lessmann Loader Co.

Magnetic Nail Picker

Apparatus for Removing Metallic Objects from Highways Described in New Mexico Highway Journal

By B. F. KELLY
District Engineer, New Mexico State Highway Department

IN line with the New Mexico Highway Department's policy to render all service possible to the traveling public, an electro-magnetic "nail-picker" has been constructed to be used in removing nails, screws, bolts, scrap iron, etc., from the state highways.

This machine was built by Co. H. R. Andrew of the Spring & Forging Co., of Roswell, assisted by the Bonney & Danenburg Electric Co. and by Chas. H. Frazier of the Southwestern Public Service Co., who offered some excellent advice and instructions for properly wiring the magnets and installing the generator.

Description of Machine.—In designing this piece of equipment, specifications were obtained from the State college of Washington, which served as a foundation upon which to plan and build the machine. Several changes were made in the specifications as furnished by the State College of Washington, and to Col. H. R. Andrew belongs the credit for this careful planning and the construction of this really effective nail-picker.

The entire plant, consisting of generator, Ford engine with which to power the generator, magnets and control switches, is built into one unit, which has been mounted on a Ford truck.

A Ford engine, equipped with an oversize radiator and circulating water pump, is used to power the generator. Connected directly with this engine and driven with a short drive shaft from the regular Ford universal joint is a three kilowatt, shunt wound, direct current generator. A throttle control is provided on the Ford engine that powers the generator, to obtain the speed desired.

Located back of the driver's seat on the Ford truck and in such a position as can be easily watched and adjusted by the operator is an instrument panel on which is mounted an ammeter, voltmeter, a field rheostat and two 250 volt light bulbs which indicate current being generated. This gives suitable control of the electric current delivered to the magnets.

Two magnets each 4 ft. long are built of 12 in. I-beams. On one side of the web 175 lb. of ⅛ in. square No. 7 compound wound wire was wound and bolted to the I-Beam to form the magnet. Over the open side of the coil is bolted a sheet of brass. This brass not only protects the coils from pieces of metal drawn up to it, but facilitates the removal of the collected iron when the current through the magnets is turned off. If the collected iron were in contact with the iron surface of the magnet core, it would not so readily drop off when the current is switched off.

At the rear of the Ford truck is a 2-pole knife switch that stops the current from going into the magnets. The switch was placed in this convenient position to enable the operator to release the current from the magnets and drop the collected iron upon a piece of canvas.

The entire unit weighs approximately one ton and was therefore mounted on a 1-ton Ford truck. The unit is placed on the truck in such a way that the radiator and crank of the power plants is at the rear. The magnets are suspended by chains from the back of the truck and hang just clear of the rear wheels. With the field rheostat, voltmeter and ammeter at the back of the driver's seat, ease and speed in operation are assured.

Operation.—One man can easily operate the nail-picker, as no operation requires a man at the front and rear of the machine at the same time.

After starting the power plant and turning the current into the magnets, the required voltage and amperes are obtained by turning the control knob of the field rheostat. It was found that the magnets were working efficiently with 80 volts and 34 amperes of current. With this current going into the magnets, nails, bolts, screws, etc., will be lifted 6 to 8 in. readily.

The operator drives the truck along one side of the road at the rate of 8 to 10 miles an hour. Faster speed than this should not be made or some of the scrap iron will be left on the road.

The collected iron should be cleaned from the magnets frequently, since too great an accumulation reduces the useful strength of the magnets. For the cleaning operation the truck is stopped and a piece of canvas spread underneath the magnets. The switch at the rear of the truck is then opened which cuts the current off and allows the accumulated iron to drop on the canvas.

The two magnets, each being 4 ft. long, cover 8 ft. of road surface on a "through" and 16 ft. on a "round." On a large part of the highways in the state it is believed that one "round". with the machine will remove the greater part of the objectional material. On wide roads, it is believed that the machine should be drawn over the road three times, starting down one side, coming back the opposite side and then going back through the center.

Results of Tests.—The first road test made of this equipment was on F. A. P. No. 48, located between Roswell and Dexter, the length of which is 16.4 miles. On the first mile three trips were made with the machine, covering 24 ft. in all. On the remaining 15.4 miles, which is a narrower road, one "round" only was made, which covered 16 ft. of roadway.

On the first mile 16 lb. of iron were collected. On the entire 16.4 miles, 70 lb. were collected. It is believed that more was picked up proportionally off the first mile due to its proximity to town, where traffic is heavier and more hauling is done. The average amount of scrap iron removed from the entire road was 4.27 lb. per mile. It was also found that a large percentage of the material collected was from the edges of the road, although considerable material such as nails, tacks and short pieces of wire, which are the cause of numerous punctures was collected from the middle of the road.

The material picked up consisted of nails, screws, tacks, wire, bolts, short pieces of spring leaves, flattened out tin cans, keys and miscellaneous scrap iron. It is estimated that at least 80 per cent of the material collected is a definite menace to automobile tires.

A second trip was made over part of the road previously covered with the nail-picker to determine if all the iron had been removed from the road on the first trip. On the second trip only a very small amount was collected. From this test it was found that 90 per cent or more of all iron was picked up on the first trip over.

To determine the power of the magnets and the weight that they would lift, various sizes of iron weights were placed in the path of the machine. A 10 lb. iron bar 1 ft. long was lifted 4 in. and could not be removed from the magnets by one man. A 10 ft. grader blade weighing 65 lb. was also lifted 4 in. from the ground and two men were required to remove it.

From Feb. 21 to Feb. 29 inclusive this machine had covered 206½ miles of road in District No. 2. All of this distance experienced at least one "round" with the machine; while a part of it was covered in one "round" and one half. On this 206½ miles have been collected 1,025 lb. of junk by actual weight. During the nine days a daily average of 23 miles of road has been covered.

Cost of Operation.—Calculated on a nine-hour day basis, both the power plant and the Ford truck will burn 18 gal. of gasoline and an average of one-half gallon of lubricating oil per day. The daily cost of operation is therefore as follows:

18 gal. gasoline at	$0.22	$ 3.96
¼ gal. lubricating oil at	1.20	.60
Estimated daily cost of repairs		1.08
Operation Wages		4.00
Operators expenses while away from headquarters		3.00
Total daily cost		$12.64

The estimated cost of repairs was figured as follows:

Six Month's Period	Unit-Cost	Total
2-32x4½ Tires at	$26.25	$ 52.50
2-32x4½ Tubes at	3.50	7.00
2-30x3½ Tires at	13.10	26.20
2-30x3½ Tubes at	1.80	3.60
30 hrs. labor by mechanic at	.60	18.00
2 motors overhauled (parts) at	25.00	50.00
Miscellaneous parts such as timers, coil points, spark plugs, gaskets, wiring, etc. at	6.00	12.00
Grand Total		$169.30

Figuring 26 working days per month over a six month's period, or 156 days, we arrived at a cost per day of $1.08.

The average speed made during the day, counting stops, was seven miles per hour. On a nine hour day 63 miles should be made with all ease.

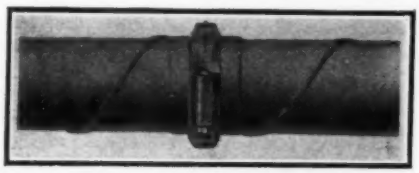
It is estimated that one "round" with this equipment on two-thirds of the roads will be sufficient to clear them of objectionable material: while three trips with the machine or a "round" and a "through" will be required on one-third of the roads. Taking this as basis, the average cost per mile for clearing the roads of scrap iron, nails, etc., will be $0.47.

When three trips are made, 21 miles of road will be covered each day. 31.5 miles of road can be covered when only one "round" is made.

Naylor Designs Pipe for Victaulic Couplings

Worth-while savings can be effected through the use of Victaulic Couplings with Naylor Spiralweld Toncan Iron Pipe, because of the low cost of installation wherever pipe is needed for conveying air, steam, water, oil, gas and materials, according to the manufacturer of that pipe.

Primarily the value of Naylor Spiralweld Toncan Iron Pipe and Victaulic



Naylor Spiralweld Toncan Iron Pipe Designed For Use With Victaulic Couplings

Couplings is in the savings it permits in time, labor and maintenance.

First, unskilled labor may be used for installing, and a minimum of time is required for attaching Victaulic Couplings, it is said. Second, an exact alignment is not necessary. Third, an additional saving is made in the cost of shipping because of the smaller dimensions of the couplings as compared with flanges, and the exceptionally light weight of the pipe. Fourth, fittings and joints may be shipped separately to save space. Fifth, lower maintenance cost, because the joints are leak-proof even when subjected to severe shock or vibration. Sixth, easy removal of any length of pipe in a line without disturbing the balance of the line means great savings in labor and time.

Naylor Spiralweld Toncan Iron Pipe, made of Toncan iron, is now available with grooved ends for Victaulic Couplings, in sizes from 4-in. to 12-in. diameter. It is adapted for use where pipe is needed for handling air, water, steam, oil and gas, and where quick, easy installation is required. Because of the absolutely smooth inside and true diameter, it reduces frictional resistance to a minimum, and almost eliminates capillary attraction, the manufacturers claim. It has the added advantage of light weight for ease and economy of handling, and yet because of the welded seam it is a pressure conveyance medium equal in strength to standard wrought iron or steel pipe.

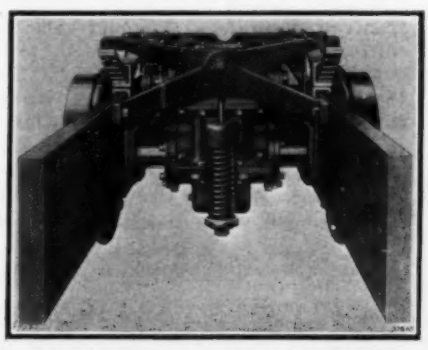
The Naylor Spiral Pipe Company will send a sample length of their pipe to anyone who is interested in better pipe for conveyance line purposes. When writing for a sample section, be sure to specify the type of end wanted, threaded or grooved end, and for Victaulic Couplings, plain or bolted joints, beveled for welding, or slip joint for welding. This company is located at 1230 E. 92nd St., Chicago, Ill.

Porter Locomotive Has New Features

A gasoline locomotive entirely new in design and drive principle has just been brought out by H. K. Porter Company of Pittsburgh, Pa.

The power plant, clutch and transmission are mounted on steel sub-frame and form a straight line drive to the reverse unit. This sub-frame acts as a troque arm pivoted on the rear axle and spring suspended at the front to the main frame. By an ingenious arrangement the weight of the rear end of the sub-frame is carried on the main frame by a coil spring. The result is that all of the vital parts of the locomotive, namely, the engine, radiator, clutch transmission and reverse unit are mounted on a sub-frame which is spring suspended to a spring suspended cross-equalized main frame.

The main frames and bumpers are made of rolled steel slabs and same as used on the famous Porter Steel Works Locomotives. The running gear, including steel tired driving wheels, side rods, driving boxes, shoes, wedges, springs, etc., is the same as on the Porter Steam Dinkey.

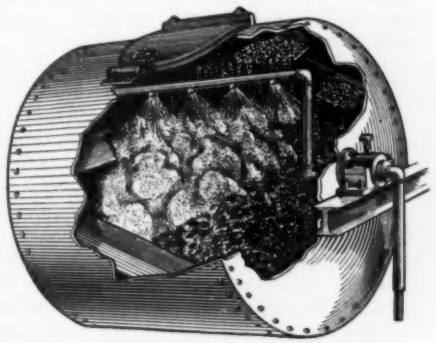


The Complete Power Plant and Transmission of the New Porter Gasoline Locomotive as mantled on the Sub-frame. This is a New Feature

Rotary-Pressure Mixer for Asphalt Plants

Asphalt and aggregate can be mixed more uniformly and more quickly, as more effectively, in a new rotary-pressure mixer recently introduced by the American Fin-Mix Company, 410 N. Michigan Avenue, Chicago, according to that firm, than in the old pg mill. Literature emanating from that source, describing the new mixer, states that this machine can mix 7,000 to 15,000 lb. of material in one batch, affording a full truck load mixed uniformly and loaded at a uniform temperature, and that a truck can be loaded in from one to two minutes when the plant is equipped with this machine.

The manufacturers claim a greater uniformity of resultant mixtures because of the large bath, premixing the aggregate before introducing the asphalt, and because of the longer mixing time. They claim complete distribution of asphalt through the aggregate by atomizing and spraying hot asphalt with pressure into the aggregate while it is in motion. All the pores and crevices in the material used are said to be completely filled by this pressure. Many grades of aggregates hitherto unusable and larger sizes may be used. Pavements made from asphalt so mixed, it is claimed, will last longer due to the greater proportion of filler and fines and because of the greater waterproofing value thus secured. Among other advantages claimed are a reduction in percentage of errors in weights on account of handling larger batches, and no loss of filler and dust nuisance around the plant.



The New Finley Rotary Pressure Mixer for the Asphalt Plant

The mixer consists of a rotating drum mounted on steel supports, provided with handhole for the insertion of the aggregates and for dumping the batch, and equipped with a spray pipe inside by means of which the hot asphalt is sprayed onto the aggregates while the drum is rotating. Deflector plates on the interior of the drum add to the mixing action just as in a concrete mixer. The spray is connected by means of a pipe line to the asphalt heater.

Highway Accidents in 1927

Causes and Suggested Remedies

By CHARLES M. UPHAM
Director, American Road Builders' Association

During every 24 hours of 1927 an estimated average of 2,261 persons were killed or injured in highway accidents —one every 39 seconds! The estimated economic loss resulting from these accidents was $672,097,000 not including insurance premiums—nearly two million dollars every day of the year.

The 1927 casualties, according to the American Road Builders' Association, showed an increase of 1,316 deaths over 1926. The total fatalities for 1927 was placed at 26,618, and the number of serious injuries at 798,700. Minor accidents involving property damage only, were not taken into consideration in the statistical report released by the association, although these accidents have been estimated to occur at the rate of 25,000 daily.

Waht do these figures show? Do they mean that the American people are becoming inherently reckless at the wheel of an automobile? Do they mean that modern cars are too fast or too inefficient to be safely operated on our present system of streets and highways and under the present traffic regulations?

Analysis of Accidents.—A careful analysis of these figures will show that no one thing may be stated as the cause of highway accidents. Such an analysis, however, will show the following facts:

1st. That the human factor is responsible for 95 per cent of all accidents and the mechanical factor responsible for the remaining negligible portion.

2nd. That the human factor which causes highway accidents is in a large degree caused by certain definable physical conditions such as complex traffic laws, traffic congestion, discourtesy on the part of other motorists, carelessness on the part of other motorists, physical incompetency, lack of confidence in the mechanical dependability of a motor vehicle and the improper conduct of pedestrians.

3rd. That approximately 60 per cent of all fatalities are pedestrians.

4th. That more than 7,300 of the fatalities in 1927 were children of school age, and that nearly twice as many persons are killed between the ages of 6 and 12 than during any other similar group of years between 1 and 70.

5th. That although highway accidents increased considerably during 1927, that increase was not out of proportion to the increased registration of motor vehicles and the growth in population.

6th. That accidents involving pedestrians continue to grow in number faster than accidents involving two vehicles or collisions with immobile objects.

Methods for Reducing Accidents.—A great mass of data has been collected by organizations interested in highway safety. Study of this material has resulted in many and varied conclusions as to the best method for reducing accidents. The American Road Builders' Association last year made such a study, and concluded that the individual alone could be held responsible for curbing the fast growing number of fatal and non-fatal highway accidents. A campaign for Courtesy and Caution was launched and the slogan found its way into thousands of schools, churches, civic and industrial organizations and private homes of the United States.

The Courtesy and Caution method for reducing highway accidents is marked with simplicity. A study of the statistical information available has led to the following objectives to be used in the conduct of such a campaign for national highway safety:

1st. The education of pedestrian traffic in the principles of simple courtesy and caution while on the public street. The use of common sense is recommended in lieu of the cut and dried adherence to a complex list of safety rules.

2nd. The thorough examination and licensing of all drivers of motor vehicles.

3rd. The adoption of a uniform simple code of traffic laws, both state and municipal.

4th. The education of drivers in the principles of simple courtesy and caution.

No accurate detailed information as to the causes of accidents and the number occurring is available. The figures given in this article, however, are approximate and are drawn from all accessible information. The following synopsis of the relative importance of accident causes is given to emphasize the paramount necessity for the practice of Courtesy and Caution under varying conditions.

Relative Importance of Accident Causes.—It is estimated that 11,765 persons were killed during 1927 in accidents caused principally by motorists. Fatalities caused principally by pedestrians is placed at 11,367, and those resulting from accidents caused principally by physical conditions at 3,486. In estimating for tabulation the various causes for these accidents, the American Road Builders' Association has used a progress report issued by the National Automobile Chamber of Commerce for 100 cities in 1926. The table follows:

Fatalities Caused Principally by Motorists		
Total killed in 1927		11,765
Inattention	32 pct.	3,765
Speeding	23 pct.	2,706
Traffic violation	20 pct.	2,353
Intoxication	9 pct.	1,059
Miscellaneous	16 pct.	1,882
Fatalities Caused Principally by Pedestrians		
Total killed in 1927		11,367
Children playing in the street or crossing in violation of traffic regulation	32 pct.	3,638
Adult jay-walking	27 pct.	3,069
Inattention	16 pct.	1,819
Confusion	14 pct.	1,591
Other causes	11 pct.	1,250
Fatalities Caused Principally by Physical Conditions		
Total killed during 1927		3,486
Fog, snow or rain	37 pct.	1,290
Defect in vehicle	19 pct.	662
Skidding	16 pct.	558
Road defect	11 pct.	383
Strong lights	7 pct.	244
Poor street light	7 pct.	244
Confusion in dimming	3 pct.	105

From the foregoing table it may readily be seen that most highway accidents are from causes which cannot be regulated by any number of traffic regulations. The three principal causes —inattention, children playing in or crossing the streets, and adult jaywalking took 12,291 lives or nearly 52 per cent of the total 23,496 fatalities for which causes were listed. No amount of enforceable traffic law will reach these causes.

What then is the solution? It is impossible to eliminate highway accidents. With 23,000,000 vehicles using the streets and highways of a country peopled with 110,000,000 human beings, there will always be fatalities both avoidable and unavoidable. It is not unreasonable to believe however, that the present toll is much too high, and that by concentrated effort on the part of organizations interested in the problem, it may be considerably reduced.

The most important immediate step that may be taken in behalf of highway safety is education of the public, both pedestrians and motorists, through the newspapers, the s c h o o l s, the churches, and through every conceivable medium for passing on a vital message. Only when the individual practices the principles of simple courtesy and caution as a part of his natural self may the nation hope for a reduction in the toll it pays for automotive transportation.

Vehicle Taxes for Road Building in Brazil

The growing recognition by local Brazilian state governments of the importance of roads to the economic development of northeastern Brazil is clearly demonstrated by the fact that three states in that section of the country have, in recent months, passed laws providing for taxes on vehicles, the proceeds of which are to be used for road building and maintenance work. Previous to the passage of these laws, according to a report from Consul Nathaniel P. Davis released by the Department of Commerce, a certain amount of road construction was carried on, but no taxes were specifically set aside for this purpose and when state revenues were small, activity in this direction practically ceased for months at a time.

Ohio Road Construction in Congested District Under Traffic

A Notable Example of a Modern Highway Improvement

By A. W. SHERWOOD

Assistant Division Engineer, Division No. 10, Ohio Department of Highways, Marietta, O.

UNITED STATES Route No. 50 extending from Annapolis, Md., to Sacramento, Calif., and Ohio State Route No. 31, which runs from Pomeroy, O., to Columbus, O., via the Hocking Valley, converge traveling eastward, at a point about 1½ miles west of the corporation line of the city of Athens. This point marks the west boundary of the village of Mechanicsburg, which extends west from the city of Athens along this route. Both these routes have registered an ever increasing traffic toll, and at the present time counts range from 1,200 to 3,500 motor vehicles per 24-hour day.

General Conditions of the Problem.—The 1½ mile portion of the road through the village of Mechanicsburg had only an old, rough, uneven, narrow 16 ft. brick pavement with concrete curbs, laid on a gravel base. This was about twelve years old. The alignment was very poor, the bridges narrow, two creeks bordered the pavement, so that shoulders were narrow, and in places there were none at all, and several residences, one school, and one church set in close to the pavement, being not more than 4 to 6 ft. from it. In addition to the heavy traffic load through this bottleneck it was frequently crowded with large numbers of children going to and from school, and many pedestrians walking to or returning from their work in Athens. At the eastern end of this section, which is known as Section B, the pavement contracts to a 14 ft. width through a stretch of about 1,500 ft., and was bordered on one side by shops, garages, etc., with automobiles usually standing in front, and on the other side by a row of beautiful elm trees that it would have been unwise to destroy.

Such were the general conditions of the problem. O. W. Merrell was resident deputy state highway commissioner of the district of which Athens County formed a part, and he decided that if he were going to do a job here at all that he would do it in a way that it should be done. If buildings were in the way they would be moved back; if creek channels were too close to the road they would be recut; and where alignment was bad it would be corrected. It was obvious too that sidewalks would have to be included with the new job, to take care of children and pedestrians, and that all drainage would have to be pipe underdrain, since open ditches through the lawns of bordering improved properties were out of the question.

The general policy of the Department of Highways of the State of Ohio, as determined and constantly stressed by the director, G. F. Schlesinger, is to give thorough study to the needs of traffic during the construction period, where an improvement is contemplated, and not to route traffic around over several miles of bad detour while a project is being built. In view of the fact that a detour around this project would have involved about eight additional miles, it was decided to build the job under traffic.

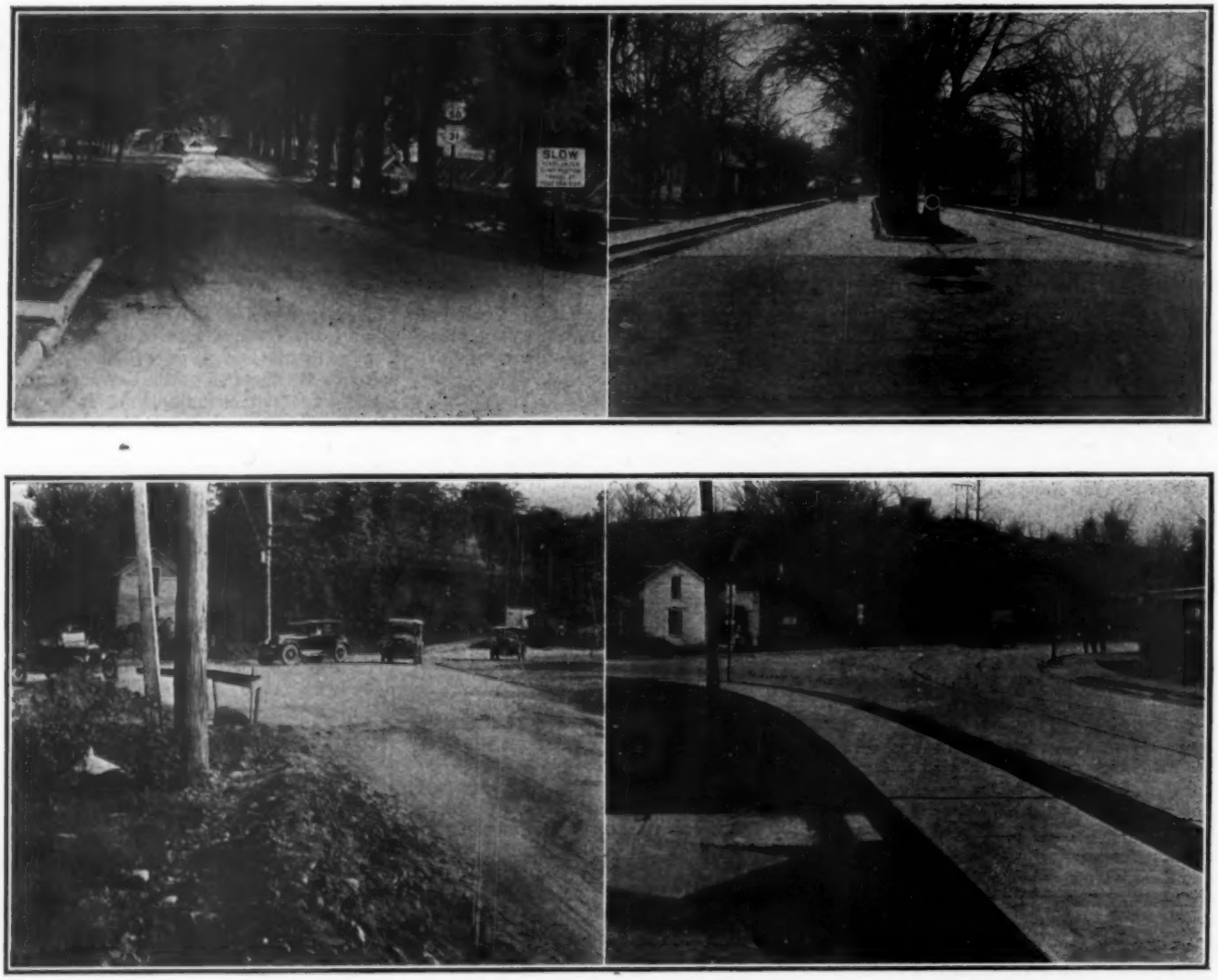
Design Features.—The general details of design embodied two types of pavement, i. e., brick on concrete base, and plain concrete with dividing plates and edge bars. It is the practice of the Ohio State Highway Department to take bids on at least two types of pavement on any paving project. It is believed that in so doing more and better competitive bids are obtained, and the manufacturers of the materials used in the different types are more likely to feel that they have been given fair treatment. That weight should be given to such procedure seems to the writer particularly appropriate, since such manufacturers are employers of labor, taxpayers, and contribute to the wealth and upbuilding of the state. Their interests should be given fair consideration.

It was decided to save elm trees at the east end of the project, heretofore mentioned, and this was done by constructing the way traffic lanes on each side of this row of trees. This added greatly to the beauty of the street, and did not detract in the least from its utility. Figure 1 is a view of this portion of the street with the row of elm trees on the right before the improvement, and Fig. 2 shows the same view after the improvement was completed, the row of elm trees in the center adding beauty and value to the project, and enhancing the desirability of the bordering residence properties.

A rolled curb was adopted because it is believed that it furnishes a greater measure of safety as compared with a vertically faced curb; an automobile, when crowded to the curb, can in emergency mount this type of curb and a collision be averted, while the vertically faced curb will usually hold it to its direction. The 26 ft. width between curbs was determined to provide for two lanes of traffic and one parking lane. This parking lane was very necessary, since it accommodates not only the short parking of resident machines but provides for the needs of tradesmen, bakers, expressmen, and the like. The dividing plates in the concrete type, were located so as to mark the different traffic lanes, and a recessed depression 4 in. wide and about ¼ in. deep was made in the pavement over each dividing plate. Concrete, when fresh, is a plastic material, and it therefore seems that some standard permanent traffic striping arrangement can be provided for when this type of pavement is constructed, and the surface not have to be continuously paint striped for years to come. This recessed depression is a feature of the design recommended by Harry J. Kirk, chief engineer. It is the purpose to lay Kentucky Rock Asphalt or other satisfactory material in these recesses to form permanent black stripes, marking the bounds between the traffic lanes. The season was so late when the job was completed that this has not been done, but these recessed lines clearly show in views of the completed project.

How the Alignment Was Improved.—Figures 3 and 4 are views of the intersections of U. S. Route No. 50 and Ohio State Route No. 31 at the west end of the project, Fig. 3 showing the conditions before improvement, and Fig. 4 the same location after the project was completed.

Figures 5 and 6, Fig. 7 and Fig. 8 give some idea of the improvement effected in alignment. It is also notable how the appearance of the residence properties is enhanced. As a matter of fact this improvement added immediately about 50 per cent to the value of all residence properties, and building lots. Sales prices of bordering properties before and after the improvement showed about this 50 per cent enhancement. On this basis the total property valuation increased was more than enough to have paid for the entire cost of the improvement. Other corrections



Figs. 1-4.—Fig. 1 Is a View Taken in June, 1927, at Beginning of Project showing Row of Elm Trees on Right Before the Improvement. Fig. 2 Was Taken in November, 1927, and Shows How the Row of Trees Was Preserved and the Appearance and Value of the Street Enhanced by Building Two 1-Way Lanes With the Trees in the Middle. Fig. 3 was Taken in June, 1927, and Shows the Conditions Before Improvement. Fig 4 Was Taken in November and Shows How the Intersection Was Greatly Improved in Width, Visibility and Safety.

in alignment and the removal of narrow bridges are well shown in Figs. 9 and 10. How a creek channel was moved back and sharp curves cut out is well shown in Figs. 5 and 6.

Some Details of the Contract.—The lowest bids were obtained on the concrete type, Type C. Inasmuch as the job was financed with county, federal and state funds, three proposals were necessary, one for additional widths over 20 ft. and the sidewalks, one for the 20 ft. width—this being the maximum width in which the state participates—and the third for bridges over 20-ft. span. The total of the three proposals on the concrete type was $105,115.75 and the job was awarded to Fred Beckler, contractor, Athens, O., at his bid of $102,755.08 covering the three proposals. The plans provided, as stated above, that the job should be built under traffic. The contract was not awarded until the latter part of July. This late sale was necessary because of changes in laws and methods of raising funds enacted by the state legislature at its last session. This was rather late in the season to begin a job of this size, and to be built under traffic. The total length was about 7,000 ft., and aside from the paving and sidewalks the project provided for about 6,000 lin. ft. of vitrified sewer pipe underdrains, with attendant catch basins, manholes, side inlets, etc., the construction of 24 structures—four of these being bridges, one of which was of over 40 ft. span—the grading of the roadway including removing present brick pavement, and comprising 4,618 cu. yd. of roadway excavation, 6,968 cu. yd. of creek channel change needed and used in roadway embankment, and 6,519 cu. yd. of borrow.

Construction Operations.—The contractor organized his force and planned his work with a view to the earliest possible completion. He had bridge construction gang, paving crews, and grading groups all working at the same time, carrying over 150 men on his payrolls for a period. Incidently such payrolls gave a nice impetus to business in a small city where commerce was at a low ebb on account of miners strike. The contractor's general plan of paving was to lay a strip 18 ft. wide with one curb, he having first completed the one way pavement 17 ft. 6 in. wide along the elm tree parcade before mentioned.

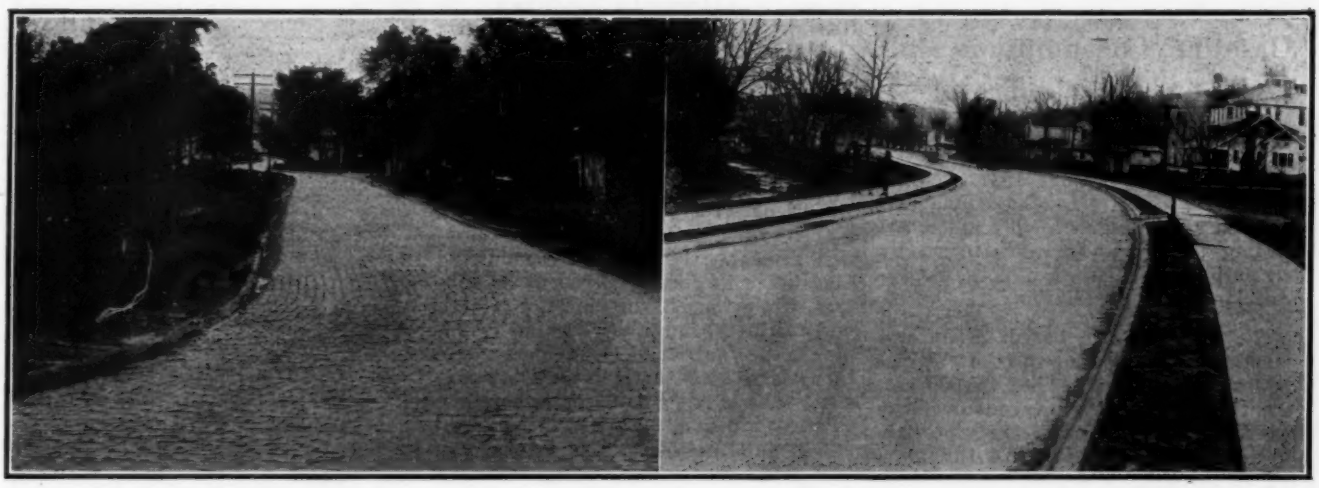
It is the practice of the Highway Department, and set forth in a letter by Harry J. Kirk, Chief Engineer, to open to traffic any portion of a concrete paving project where test beams taken from the paving mix show a flexural stress or modulus of rupture of 500 lb. per square inch, and where the age is not less than 7 days. Test beams taken from day to day on this project were tested to failure when 7 days old, and these invariably showed an ultimate flexural strength of over 500 lb. per

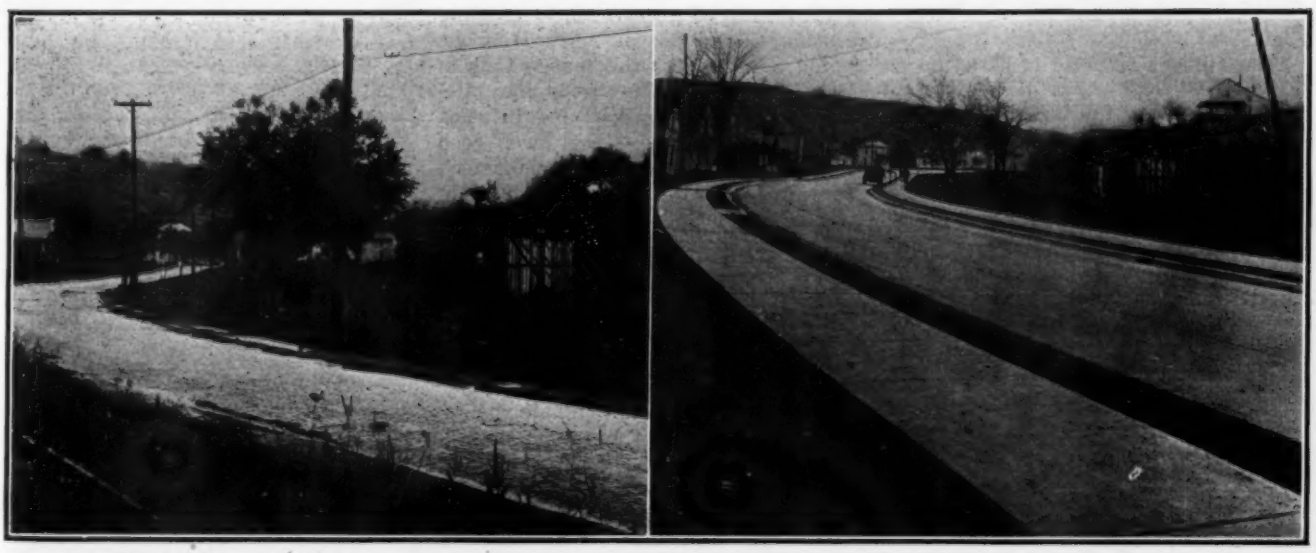
square inch, the average being 652 lb., and many beams running over 750 lb. It was necessary, therefore, to keep closed to traffic only about a week's run of paving. Traffic in one way lane was routed along the side of the 18 ft. strip first laid, that is along the side of a week's run.

How Traffic Was Handled During Construction.—Guards were stationed at each end of such one way section, the last machine of a traffic group carrying a flag through to the guard at the other end, who had, in the absence of his flag, been holding back the traffic at his end; he would, upon the arrival of the flag, advance his traffic group, the last machine carrying it back. This scheme, which of course was employed day and night, worked very satisfactorily. In no case did the interruption to traffic cover a period greater than 15 minutes, and generally it was much less. Incidently it may be remarked that where traffic is lighter and the predominant trend is in one direction, and the one way lanes longer, that it is better to install telephone booths with guards at each end of a closed paving section, because with the flag carrying system it is necessary for a traffic group to form before the flag can be returned. This latter method has been used on other jobs in southeastern Ohio, where traffic was not so great, or the predominant trend was in one direction, and in such cases is much more efficient and necessitates fewer delays than the flag carrying system.

Progress of Work.—While no paving records were broken, nor such attempted, daily paving runs were high and well maintained. Seven to eight hundred feet of paving 18 ft. wide with one curb were common daily runs, and such runs seldom fell below 500 ft. One thousand lineal feet of sidewalk 5 ft. wide was laid in a working day of 8 hours, the finishers working overtime, 700 ft. being about the daily average. The bridges and structures were all completed and the 18 ft. strip of pavement throughout opened to traffic on Sept. 28th. After this the 9 ft. strip with the other curb was laid with no hindrance to traffic over the 18 ft. strip. Sidewalks, berms, etc., were all completed, and the job accepted in mid November.

The Personnel.—M. W. Wilbur, highway engineer in Ohio for the U. S. Bureau of Public Roads, whose office had to recheck and approve the plans, followed the work closely. The engineering was under the supervision of the Bureau of Construction of the Department of Highways, which Col. R. S. Beightler is chief engineer, and whose bureau has general supervision of construction over the state. Athens County is in Division 10 of the state of which O. W. Merrell is the Division Engineer, as mentioned above. John W. Dowler, Assistant Engineer, Athens, Ohio, was the local engineer for the state in direct charge of the preliminary surveys, the preparation of plans, and of the construction. G. F. Schles-





Figs. 5-8.—These Illustrations Give an Idea of the Improvement Effected in Alignment. Fig. 5 Was Taken in June, 1927, Shows the Creek Channel Before Improvement. Fig. 6, Taken in November, 1927, Shows How the Creek Channel Was Recut Away from the Road and Alignment Corrected. Fig. 7, Taken in June, Shows the Sharp, Dangerous Curvature Before Improvement and Fig. 8, Taken in November, Shows the Correction of the Curvature

Figs. 9-10.—Fig. 9, Taken in June, Shows the Narrow and Dangerous Bridge, and Fig. 10, Taken in November, Shows the Improvement

inger is Director of the Department of Highways and H. J. Kirk, Chief Engineer.

Gasoline Consumption and Motor Vehicle Travel in 1927

Each motorist during 1927 used an average of 550.9 gal. of gasoline and traveled an average of 7,437 miles, according to figures just announced by the national headquarters of the American Motorists Association.

The averages are based on a total gasoline consumption in the United States amounting to 11,563,490,000 gal. —an increase of 12.4 per cent over the gasoline consumption by the motorists of the country during 1926. Eliminating all re-registration figures, the U. S. Bureau of Public Roads places the total motor vehicle registration as of July 1, 1927, at 20,991,333.

The mileage traveled is based on an average of 13.5 miles per gallon of gasoline. Using this figure, the Association places the total number of miles traveled by the 20,991,333 cars and trucks during 1927 at 1,561,071,150,000 miles.

One of the interesting things shown by the survey of gasoline consumption is the wide variation in the amounts consumed per automobile capita. For instance, the highest per capita consumption was in Georgia, the 260,079 vehicles averaging 739 gal. during the year, while the lowest was in Minnesota, the 607,725 vehicles using an average of but 359 gal., or slightly less than half the per vehicle consumption in Georgia.

"Many things contribute towards the wide variation in the amount of gasoline used per vehicle in the various states," according to J. Borton Weeks, president of the Association. "In the wide difference between the amount consumed by the average motorists in Minnesota and Georgia, the primary reason is climatic conditions. In Georgia automobiles are used the year around, while in Minnesota they are restricted. Again roads in Georgia are not as good as those in the northern states and hence the gasoline consumption is higher."

Additional factors accounting for the variations, President Weeks points out, is that of population, gasoline consumption being heavier in thickly populated areas such as cities and industrial centers, while tourists account for a high per capita consumption. As an example, in the District of Columbia—where there is a large annual tourist movement—the average is 79 gal. above the general average. From an industrial standpoint New Jersey's per capita consumption stands out, being 88 gal. above the country's average.

"The ratio of good roads to gasoline consumption is not as marked as one would suppose, for the reason that in states where roads are good the mileage is more per gallon, and in most instances the states that have good roads are wealthy and one of the unique angles of per capita gasoline consumption is that in the wealthy states, where many owners own two cars, the per capita consumption is lowered by virtue of this fact," President Weeks points out.

"This is particularly true of California, which has excellent roads and an all year motoring climate. With these two factors one would suppose the per capita gasoline consumption there would be the highest, however, with a per capita gasoline consumption of 642 gal. California ranks fourth on the list. Following Georgia, Louisiana ranks second with 721 gal. and Alabama third with 697 gal."

The per capita consumption in the 48 states and the District of Columbia as made public by the American Motorists Association for 1927 is as follows:

State	Gallons
Alabama	697
Arizona	591
Arkansas	565
California	642
Colorado	552
Connecticut	610
Delaware	567
District of Columbia	629
Florida	663
Georgia	739
Idaho	486
Illinois	550
Indiana	466
Iowa	430
Kansas	595
Kentucky	468
Louisiana	721
Maine	527
Maryland	527
Massachusetts	451
Michigan	567
Minnesota	359
Mississippi	598
Missouri	528
Montana	557
Nebraska	523
Nevada	566
New Hampshire	528
New Jersey	638
New Mexico	606
New York	524
North Carolina	525
North Dakota	609
Ohio	528
Oklahoma	547
Oregon	639
Pennsylvania	480
Rhode Island	593
South Carolina	584
South Dakota	513
Tennessee	560
Texas	623
Utah	489
Vermont	486
Virginia	494
Washington	583
West Virginia	494
Wisconsin	501
Wyoming	568

Road Building Program for Lithuania.—A $20,000,000 plan for road building in Lithuania was recently accepted by the Cabinet of Ministers. It is planned to build 1,205 miles of highways and 118 miles of roads from various towns to railroad stations. The work is expected to be completed within ten or fifteen years.

Methods and Costs of Highway Maintenance in Macomb County, Mich.

Salient Features of Roadside Cleanup

By W. J. LEHNER
Engineer-Manager Macomb County Road Commission

MACOMB COUNTY, is the Northeasterly neighbor of Wayne County and has absorbed a large number of citizens who work at their trades or professions in Detroit and live here, where home plots are large enough to permit domestic tranquilities to be cussed or discussed without static.

The County Road System. — The county road system was born in 1912 and since then the population has increased from 30,000 to 85,000 and the assessed valuation from $26,000,000 to $121,000,000. The first pavements were 16 ft. in width and 4 ft. shoulders. The most recent design is a 20 ft. pavement slab, 8 in. thick at center and 10 in. thick at edge and reinforced with approximately 5 lb. of steel per yard. The slab is divided by center construction joint, and by transverse construction and expansion joints alternating at 60 ft. intervals. Shoulder widths are from 15 to 18 ft. depending on available space.

Up to this time there has been constructed 121.6 miles of cement concrete, 25.8 miles of asphaltic concrete on cement concrete foundation, 4.5 miles of bituminous macadam, and 181.5 miles of gravel surface roads, making a total of 333.4 miles, exclusive of state trunk lines and this, bear in mind, in a county 30 miles long, north and south, and 10 to 18 miles wide, East and West.

Maintenance Districts.—To maintain this network of roads, the county has been divided into four districts, No. 1 N. W., No. 2, N. E., No. 3, S. E., and No. 4, S. W., with division headquarters or yards as near the geographical center of the district as railroad sidings will permit. Then in turn these four districts have been divided into approximately 90 maintenance sections ranging from one to 13 miles in length. Each section carries a prefix numeral of the division it is in. Each section can have but one type of construction to provide intelligent maintenance costs. Each one of the four districts is in the charge of a division superintendent and these men receive their orders from their chief, the superintendent of county maintenance.

The Budget.—This maintenance department operates on a definite budget which is made up in October and submitted first to the County Road Commission then to the road committee of the Board of Supervisors and finally to the Board of Supervisors. When approved, the budget becomes the guide for the following year's maintenance, which for the year 1928, is $100,000 for 333.4 miles or an average of $299.94 per mile. Bi monthly reports are made by the Maintenance Superintendent covering expenditures and budget balances.

To intelligently discuss the budget, it is first necessary to explain what is included in the term maintenance. The road must present a neat appearance and be fit for travel each day of the year. A road up to standard indicates that the shoulders, side slopes and ditches must be in good order. It does not mean that all shrubs must be removed. In many instances shrubs found along the roadside should not only be saved, but trimmed up and growth encouraged. Tree planting, warning signals at all dangerous locations, and road information signs should be properly placed and maintained. Weeds, tall grass, rubbish, papers, leaves and unnecessary signs should be removed from the roadside.

These items are all reflected in the budget and the budget for each section is made up in the following form:

A. Road Bed

1. Filling shoulders, ruts and washouts.
2. Mowing grass, seeding shoulders.
3. Cleaning out ditches.
4. Building shoulders.
5. Cutting brush and weeds.

B. Structures

1. Painting, repairing guard rails.
2. Repairing culverts, culverts of same size that are removed must be replaced.
3. Cost of snow fences, erecting same and taking down.
4. Bridges.

C. Dragging

1. Floating, scarifying.

D. Patching

1. Tarring cracks, joints and replacing breaks on concrete and asphalt roads.

E. Dust Layer, or Snow Removal

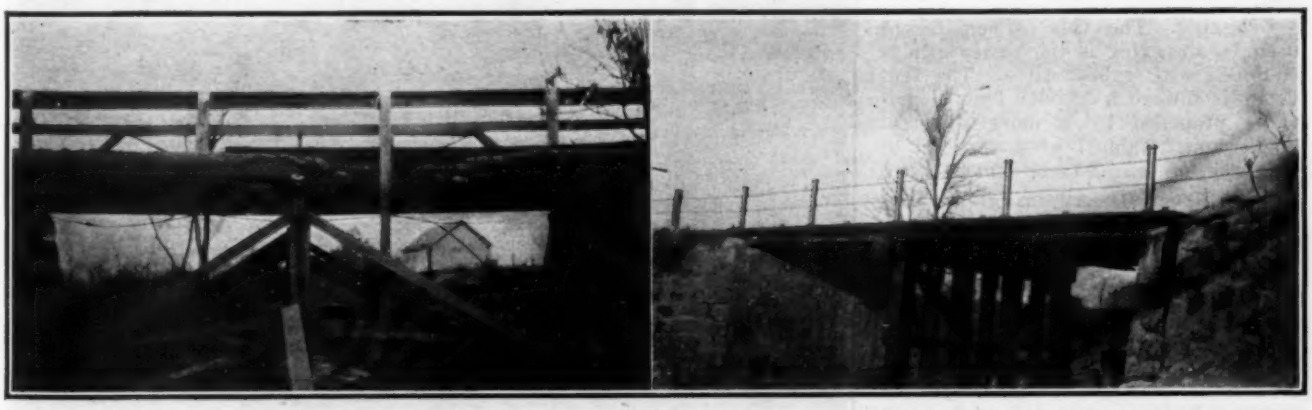
1. Application of light oils. (Very rarely used.)
2. Application of calcium chloride.
3. Snow removal—all charges for same. (Note: Snow fence is not included under this heading.)

F. Resurfacing

1. All extensive gravel resurfacing must be charged to resurfacing.

G. Traffic Census and Weighing Trucks

1. Traffic census, all work for same.
2. Truck weighing—all work for same.



View of Bridge Just Before It Was Taken Down for Rebuilding. Same Bridge After a Bent Has Been Installed and Floor System Revamped at a Very Small Cost. County Is Standardizing on Carrying Cable Guard Rail Across Bridge Using Steel Posts as Shown in Illustration

Mail Boxes as Set Up by Residents and Same Boxes Put Upon Rack Furnished by County

H. Markers and Signs

1. Painting and erection of all signs.
2. Pavement marking.

I. Betterments

1. The first year treatment of all roads.
2. The erection of new guard rails, where no guard rails extended.
3. The installation of new culverts where no culverts previously existed, or where a larger culvert is constructed than the one taken out.
4. The widening of grade.
5. Widening curves and new relocations.
6. Note: The cost of new right of way for relocations or where curves are widened is also to be charged to betterments.

The main headings of the budget will be taken up in turn. The first to be discussed is structures.

Structures.—Macomb County being situated adjacent to Lake St. Clair is the outlet of a comparatively large water shed, and this involves a great number of bridges. Many of these were built by townships and are safe for light loads only. These are being painted and improved by cleaning out bridge shoes and then concreting around them to keep road materials out; by reinforcing or replacing floor systems, and placing center bents where the water area will permit. Twenty bridges have been improved in this manner at a comparatively small cost.

Dragging.—The type of equipment used for dragging is the power grader equipped with rubber tires. The tendency is toward a heavier framed machine propelled by a more powerful power unit. Table I gives the cost of operation on ten of these units.

Snow Removal.—All dragging equipment together with eight trucks operating with single blade plows in front and with 15 to 18 ft. side wings are used for snow removal. One large double mould board plow propelled by a 10-ton tractor is kept in readiness to remove drifts that form in the hilly section or Northwest portion of the county. This equipment is called out as soon as 2 or 3 in. of snow has fallen and remains on duty continually until roads and shoulders are cleared of snow. Crews are changed at 12-hour intervals. The plan is to have track broken on all roads in twelve hours, and shoulders and road sides clear of snow in 36 hours. The cost to date this winter is approximately $12.00 per mile of road.

Resurfacing.—All gravel for this work is obtained from seven county-owned and operated gravel pits. The gravel is screened and crushed to a maximum size of ¾ in. The gravel is spread in very thin coats to prevent an excess of loose materials. The resurfacing will start about March 1st and be completed before May 1st. Resurfacing at this time will reinforce the road during spring breakup and will knit better than at any other time during the year.

Traffic Census.—The traffic census counts indicate that the light traffic roads carry an average traffic during the summer months of 250 vehicles for a 14 hour count and the heavy traffic roads 5,300 vericles for a 14 hour count. There is a type of conveyance that should receive special attention particularly where the secondary, if not the primary roads, are involved, and this is the heavy trailer for moving large and heavy equipment. As several makes were shown at the road show, it indicates a marked activity in the field. If the roads are to be constantly subjected to this traffic, then we must build the roads and bridges stronger. Very few of the existing highways will continually withstand such loads, ranging upwards of 20 to 40 tons.

Weighing Trucks.—The road system is used quite extensively by fleets of milk trucks and trailers, by trucks hauling farm and garden produce; also by a large number of heavier vehicles hauling castings, merchandise, cement, etc. Unusual vigilance on the part of the special deputy in charge of weighing, has, in general, kept the loading within state limits, and the actual arrests are decreasing. The 1927 report of this deputy is as follows:

Total trucks weighed, 1927	642
Total trucks arrested and fined	138
Total cost of truck weighing	$2,433.20
Cost per truck	3.79
Total amount of fines	2,177.95

Table I.

Grader	Gallons gas	Gallons of gas per mile	Road miles graded	Hours worked	Average cost per mile
51	2,995	.768	3,898	1,986	$ .744
52	2,151	.650	3,307	1,722	.718
53	1,985	.670	2,963	1,438	.708
54	1,413	.754	1,874	985	.705
55	2,338	.696	3,357	1,682	.731
56	2,044	.805	2,538	1,608	.925
57	2,763	.794	3,478	1,814	.735
58	2,006	.664	3,019	1,645	.801
59	1,951	.686	2,842	1,347	.697
60	2,016	.658	3,063	1,679	.806
Totals	21,662	.....	30,339	15,906	.....
Total average gallons of gas per mile	.....	.715	.....	.....	$0.757

Equipment Used for Burning Brush, Weeds, Leaves and Other Roadside Vegetation

Markers and Signs.—Painting is done in general by the use of a paint spray outfit. Warning signs and guard rails are painted federal yellow. Distance and direction signs, black and white, and mail boxes, etc., are painted grey to make them as inconspicuous as possible. Flashing light warning signals have been installed at 81 improved road intersections and railroad crossings. In addition, 55 multiple lens reflectors have been placed at dangerous curves, narrow bridges, road ends and gaps in pavements.

Road Bed.—The building and widening of shoulders usually accompanies the cleaning of ditches. As indicated earlier, the road system includes many miles of roads with narrow shoulders. In many such cases, the road ditches need cleaning. The best method found for doing this combined job is by use of plow and backfiller.

Weed Burner.—Brush, weeds, leaves and other roadside vegetation is being removed by a weed burner. The machine was developed by the maintenance department, about a year ago and experimented with during the year 1927. The principle of this burner is to produce a long hot torch-like flame directed toward the ground and kept there as long as possible. This method entirely consumes the vegetation instead of leaving a slow smoldering fire in its wake.

This equipment consists of a 30 h. p. gas engine driving an air compressor which is directly connected to a 150 gallon fuel tank and to the burner nozzles. The safety valve is installed to insure a constant pressure of eight pounds. These units, together with two water barrels weigh approximately 3,000 lb. and are mounted on a truck. The burners, of which there are two, resmble elongated wheel barrows. The nozzles are at one end, operating bar at other, and wheel in center. The air and fuel lines from truck to nozzles are made of rubber tubing. The flame is adjusted by regulating the air and fuel nozzles separately. A mixing valve is not used at this time.

The operating crew consists of truck driver, two burner operators, one for each side of ditch and two additional men to clean out culverts, improve minor drainage conditions, and to exterminate any remaining small blazes.

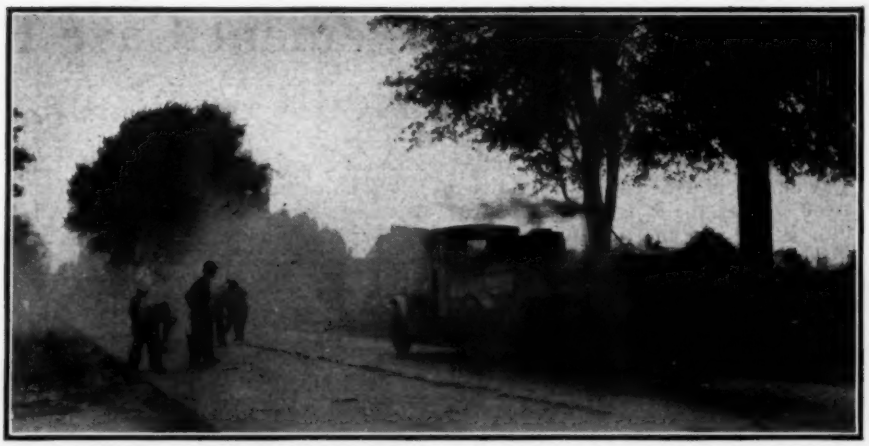
Table II is a summary of Weed Exterminator report—September 9th to October 17th, 1927: (On one side of road).

Total average cost per mile of roadside, including cleaning out driveways and cross culverts is $20.60 per mile, or $41.20 per mile of road.

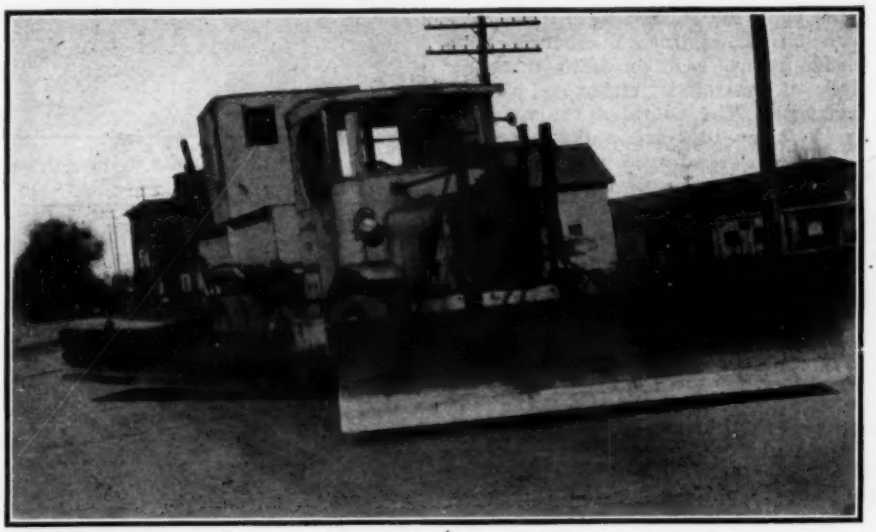
It should be borne in mind that the machine is still in experimental state and that the operation was by an inexperienced crew. It is safe to predict that the cost per mile will be reduced to $25.00.

The burner retards the growth of grass and destroys weeds by consuming the seeds; thus, the roadside is left in a very satisfactory condition, clear of all rubbish, papers, and vegetation.

Acknowledgment.—The foregoing is a paper presented at the 14th Annual Michigan Conference on Highway Engineering, held at the University of Michigan, Feb. 14 to 17.



The Tarring Crew. The Man Ahead Is Sweeping Out the Joints and the Second Man Is Holding the Cone-Shaped Pouring Pot with Central Rod Shut-Off. Directly in the Rear of Him a Man Is Following with a Sand Covering. The Two Men in Foreground Are Repairing a Small Break



Type of Snow Plow Used by Macomb County. The Side Blade Was Built in the County Shops and Can Be Elevated to Almost Any Position

Table II.

Date	Section	Hrs.	Labor	Truck rental	Miles	Gallons oil used	Cost per mile
9- 9-27	208	10	$16.50	$11.97	1.25	60 ($5.58)	27.24
9-13-27	19-2	10	16.50	11.97	.50	90 (8.37)	73.68
9-14-27	19-2	10	16.50	11.97	1.25	180 (16.74)	36.17
9-15-27	19-2	10	16.50	11.97	1.25	120 (10.16)	30.91
9-16-27	19-2	10	16.50	11.97	1.50	135 (12.55)	27.35
9-17-27	19-2	10	16.50	11.97	1.50	140 (12.82)	27.53
9-19-27	19-2	10	16.50	11.97	4.00	190 (17.67)	12.04
9-21-27	19-2	7	11.55	8.38	3.00	145 (13.48)	11.14
9-27-27	19-2	4	4.60	4.79	2.00	110 (10.23)	9.81
10-11-27	19-2	8	21.20	9.58	1.25	60 (5.58)	29.09
9-21-27	214	3	4.95	3.59	1.25	55 (5.12)	10.93
9-22-27	214	4	6.60	4.79	1.25	100 (9.30)	16.55
9-23-27	214	4	6.60	4.79	1.25	120 (10.16)	14.37
10- 6-27	215	10	26.50	11.97	1.25	100 (9.30)	38.22
10-10-27	215	2	5.30	2.39	.25	20 (1.86)	38.20
10-10-27	214	3	7.95	3.59	1.00	60 (5.58)	17.12
10-11-27	212	2	5.30	2.39	.50	25 (1.32)	18.02
10-13-27	213	10	26.50	11.97	2.00	175 (16.27)	27.42
10-15-27	213	10	26.50	11.97	2.50	175 (16.27)	21.94
10-17-27	213	10	27.00	11.97	4.25	210 (19.53)	13.76
Total	.....	147	$296.05	$175.96	33.00	2270 ($207.89)	.....

21,000 Motor Vehicles in Russia.—Motor vehicles registered in all of Russia totaled 21,035, as of July 1, 1927, according to figures furnished the U. S. Department of Commerce, 78 per cent being state owned, 7 per cent cooperatively owned, and 15 per cent privately owned. Figures compiled by the American Motorists Association show that this is one motor vehicle to every 6,723 inhabitants in Russia, compared with one automobile to every five persons in the United States.

Job Management Gave Profit On Difficult Viaduct Job

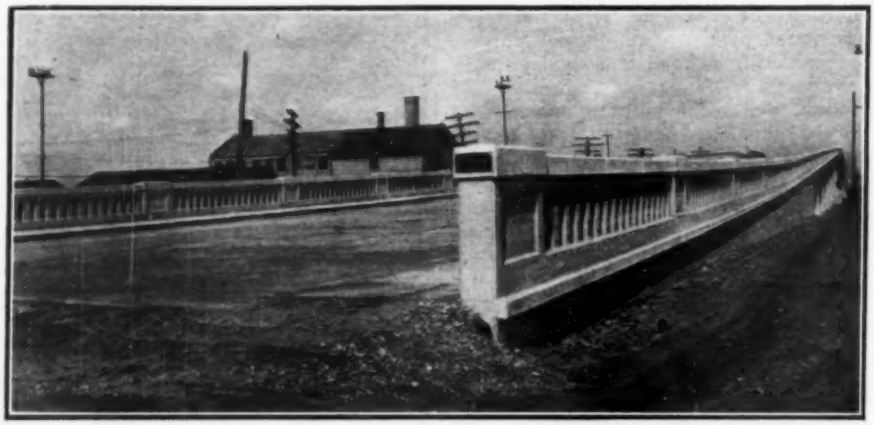
THIS highway bridge, or rather viaduct, is located where Halsted Street crosses the I. H. B. railroad at 140th Street, in the Calumet district on the far south side of Chicago, Ill. It was erected for the Illinois Division of Highways and is known as Route 1, Section K-V, on this important state highway.

According to G. N. Lamb, District Engineer, under whose supervision and control the viaduct was constructed, it has a total length of 1,460 ft. The structure consists of one 60 ft. through steel girder span, two spans of the same type 100 ft. in length, and sixteen 50 ft. reinforced concrete deck girder spans, together with retaining walls of concrete at either end 200 ft. in length. The width of the roadway is 43 ft. and the sidewalks are 6 ft. wide. The reinforced concrete bents that carry the structure are founded on a total of 1,430 pieces of untreated wood piling having an average length of 22 ft. The structural steel is encased in gunite.

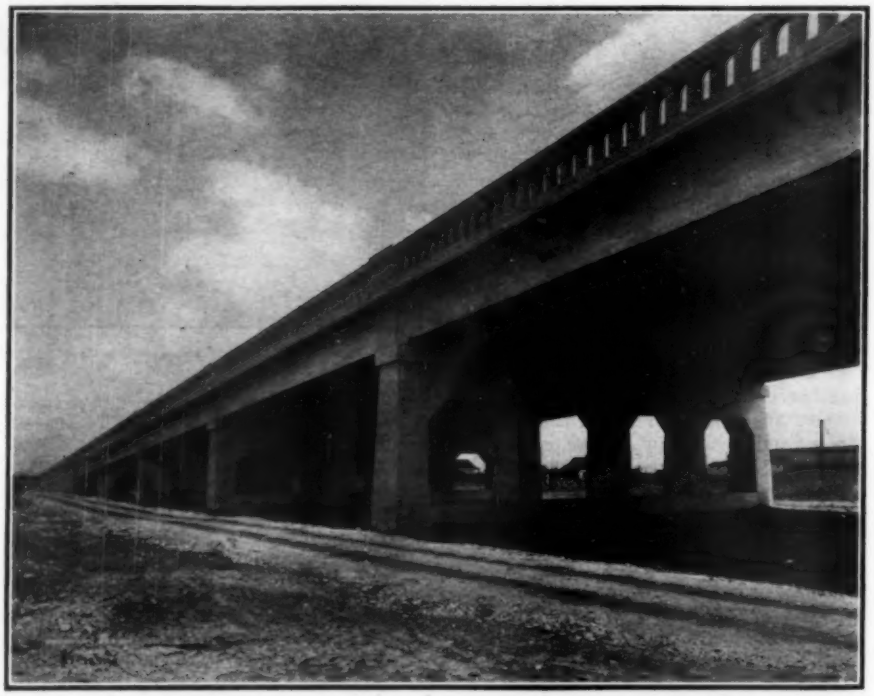
This structure was completed in the early part of 1927, and took ten months to build, and cost the State about $310,000.

According to F. J. Herlihy, President, the Mid-Continent Construction Company, general contractors on the job, a number of interesting methods were used on this job that resulted in early completion, a good profit, and good workmanship. This firm, took especial pains with their formwork on this job. Here every piece was cut to plan and carefully matchmarked so as to eliminate waste and confusion. The handrails were cast in wood forms, and a pleasing finish resulted. All centering was carefully figured for stresses and settlement eliminated.

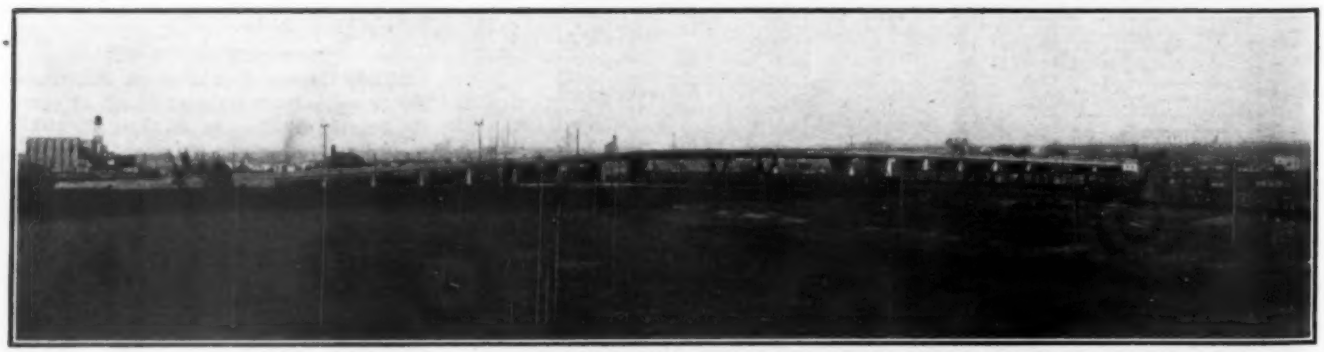
The concrete was handled scientifically so as to get high early strengths in spite of cold weather. In short Mr. Herlihy credited his success to planning and handling every last detail so that everything followed the prints, no confusion or question could arise that had not been covered, accurate bills of material showed every detail in advance, and every last move was made to count. The result was a very good job at a very good profit.



An Approach Showing Ornamental Handrail Cast on the Job



The Girder Spans Were Carried on Concrete Bents to Wood Piles



General View of the Viaduct on the Halsted Street Viaduct Over The Indiana Harbor Belt Line

The 6-Legged Tetrahedron

A Method of Highway Bank Protection Described in California Highways and Public Works

By E. T. SCOTT

Assistant District Maintenance Engineer, California Highway Department

IF the Santa Clara River were allowed to choose its own course, it would flow some place other than under the present 2,077 ft. state highway bridge near Montalvo, on the Los Angeles-Ventura Highway. On several occasions during the last few years the river, swollen by flood waters, has swung sharply to the west, cutting away the 15 ft. embankment on that side of the river, and destroying several acres agricultural land.

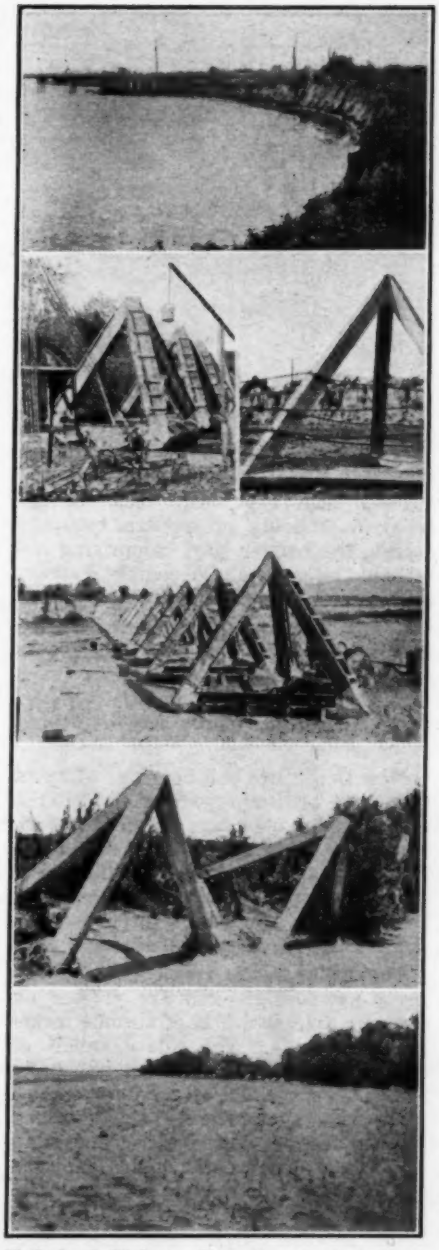
During the storm of February, 1927, the river took another swing to the west at a point about 1,200 ft. upstream from the state highway bridge and continued to wash away the high river bank until it threatened to cut through the west approach to the bridge. Only the vigorous action on the part of the maintenance organization, the crew working night and day, prevented the highway from being washed out.

Tetrahedron Answer to Problem.—The trees, cable and brush used successfully by the maintenance crew during the storm, in preventing the flood waters from cutting through the highway, offered but a scant barrier to further inroads from the stream during floods of the winters to follow. Studies were made to determine the best means of bank protection for the particular case. An inspection made of various types of bank protection work used in the Santa Clara River showed that the only type of permanent bank protection that had successfully withstood the floods was the concrete skeleton tetrahedron.

Success Proved.—The use of concrete skeleton tetrahedrons to control the river was first employed by Dan Sheldon who has owned and operated for many years a 400-acre ranch immediately north of the state highway and located along the west bank of the river. Beginning back in 1912 Mr. Sheldon invented and constructed and placed at strategic points along the river, concrete tetrahedrons which have been most successful in controlling the flood waters of the Santa Clara river.

Standing 13 ft. high, composed of six 16 ft. legs a foot square, well reinforced with steel, and weighing about 7 tons each, the concrete tetrahedrons are capable of withstanding a tremendous force.

Should the tetrahedron be undermined or even toppled over by the flood, it still stands on a broad base always offering resistance to the on-rushing water. Several years ago one of the 7-ton tetrahedrons standing at the end of a row, and not cabled to the adjoining tetrahedrons, was washed a quarter of a mile down stream by the flood. It took hours for the heavy concrete figure to cover the quarter mile and each time it rolled to a new one of its four similar bases, it stood upright, always resisting the force of the river. After the storm the strayed tetrahedron was dragged back to its place with a tractor, having suffered no damage during the trip.



Method of Highway Protection Against Flood Adopted on the Santa Clara River in Ventura County. The Upper Picture Shows the Damage Done by High Water Eating into the Bank, Beneath it is a picture Showing How a Tetrahedron Is Anchored. Next Below It, Is a Picture of a View of a Line of Tetrahedrons in Place. The Next Picture Shows the Tetrahedron Tilted by Flood Water but Still in Place. The Lower Picture Shows Brush and Trees Growing Up Behind the Tetrahedron and Reestablishing the Natural Bank

Makes Its Own Barrier.—A large amount of driftwood and brush is carried by the Santa Clara River during flood times. Soon the drift begins to accumulate against the row of concrete tetrahedrons laced together with cables. As the tangle of brush increases, the swift current of the river is halted a little and the silt and sand carried by the water begins to drop and accumulate both upstream and downstream from the obstruction, and the river veers back to its old channel. In a very short time the row of tetrahedrons stops the flood with a wall of brush and sand that the river itself has built.

Details of Job.—In order to adequately protect the highway embankment and force the river over toward its old channel, a row of 30 concrete skeleton tetrahedrons placed approximately 19 ft. apart from the center of one to the center of the adjoining one, was constructed along the west bank of the river on the upstream side of the bridge.

The row of tetrahedrons, nearly 600 ft. in length, was constructed from the river bank at an angle swinging downstream, and completely crossing the newly cut low water channel of the river.

During the construction of the straight row of the thirty tetrahedrons, ranchers owning property along the east bank of the river, over 2,000 ft. away, objected to the continution of the work as originally planned fearing that flood waters would be forced across the river to do damage to their property. In order to appease the fears of the complaining ranchers and at the same time without lessening the effectiveness of the protection work, an angle was thrown into the line and the six tetrahedrons furthest from the bank were constructed at a right angle to the direction of the bridge.

Method of Making.—The concrete skeleton tetrahedrons were made up of six legs, each 12 in. square and reinforced with eight ½-in bars, the two outside corner bars of each leg being 17 ft. 6 in. long, bent into and tied to the opposite corner bar of the adjacent legs, and six bars 14 ft. long extending into adjacent legs, at the junction. A spiral reinforcement of a number 8 wire was wound with a 6-in. pitch, around the longitudinal reinforcing bars.

Each leg, measured from corner to corner, was 16 ft. long, the height of the tetrahedron from the ground to the vertex being approximately 13 ft.

Steel reinforcement was assembled where the tetrahedron was to be constructed. Sheet iron corner forms were then slipped over the reinforcing bars at the three corners of the base and wooden forms for the legs set in place. A sheet iron corner form similar to those used on the base corners, but having a small opening at the top to admit concrete, was used at the vertex of the tetrahedron.

Concrete was poured into the lower part of the tetrahedron direct from

wheelbarrows, and when it got too high for the wheelbarrows, it was shoveled into the forms, while the last few cubic feet of concrete to be placed at the top was elevated by a bucket attached to a portable swinging teeter beam.

How They Were Placed.—The row of tetrahedrons was placed with the 16 ft. sides lining up on the upstream side, with the points of the equilateral bases downstream. A space of 3 ft. was left between the corners of adjoining tetrahedrons on the upstream side.

Six lines of old 1-in. cable, secured from nearby oil fields, were stretched along the upstream side of the tetrahedrons, with one line along the downstream side of the row. The cables were fastened in place by wrapping around the legs and by the use of cable clamps, the purpose of the cable being to tie the whole row of tetrahedrons together so that they would act as a unit during a flood, and also to catch and hold the brush and trees carried down by the storm waters.

At the bank end of the protection work, the cables were cast into a large block of concrete which anchored them at a safe point to the river bank. Some brush was piled in near the bank to prevent any possible cutting in back of the protection work.

Cost of Work.—The reinforced concrete tetrahedrons were constructed at a cost of about $112 each, exclusive of the cables, the construction of a temporary road into the river bottom, and a ditch which was necessary to deflect the river away from the construction work. The cost of the protection work, including all expenditures, was a little over $7 per lineal foot.

Work was performed by a day labor crew with Foreman Roy Stover in charge.

New 10-Ton Monarch Tractor Announced

Monarch Tractors Corporation, Springfield, Illinois, has now in production and is making deliveries of the new 10-ton Model "F." While in general it retains all of the powered advantages which have previously characterized the 10-Ton, some improvements and new features have been incorporated which add to the appearance as well as to the efficiency of the machine. These changes include heavy structural main frame, a new type of transmission case, oil tight chain housings and an entirely new design of truck roller frame and track assemblies. The over-all height has been slightly reduced, and the over-all width increased. The weight remains substantially the same, 21,500 lbs.

The change in the transmission is only in the shape of the case itself and no change has been made in the transmission mechanism. Master clutch and steering clutches are also the same as previously used and the same heavy

The New Monarch 10-Ton Tractor

duty four-cylinder motor is retained. This motor is of special LeRoi-Monarch valve-in-head type, full enclosed, the crank case being of modern two-part design, the bottom part comprising detachable oil pan, to give complete access to all crank shaft bearings.

A flexible connection is provided between the master clutch and the transmission, and the arrangement is such that the master clutch may be removed as a unit, without in any way disturbing other parts.

New Departure ball bearings of extra large size are employed throughout the transmission; all gears are of cut steel, hardened, running continuously in oil. The gear set is of selective sliding gear type, three speeds forward and reverse. By changing two chain sprockets, optional road speeds are available.

The roller truck frames are of entirely new design, and are pivoted on the rear axle, which is of chrome nickel steel, 4 in. dia. The side channels of the truck frames are of an unusually heavy type, rivited, trussed and braced to provide all necessary strength and rigidity for the most difficult operating conditions. The weight of the front end of the tractor is spring mounted onto a bracket pivoted on the equalizer bar, which in turn carries the weight onto the truck frames through large ball and socket joints. This construction accurately distributes the weight and provides a proper oscillation of the tracks for climbing obstructions and operating over rough ground.

The five truck wheels on each side are of improved heavy-duty type, comprising cast hubs with drop forged steel rims and turning on large Hyatt roller bearings, with inner and outer races. The front idler sprocket is a heavy steel casting with side flanges mounted on Timken roller bearings. The track drive sprocket is of manganese steel, split ring type, bolted onto a hub, and the rear chain drive sprocket is also of ring type, being cut from a steel forging, case-hardened and bolted onto a hub.

The 10-ton tracks are of new and distinctive type, being built entirely of manganese steel, a material which is unequalled in its resistance to wear. For the first time a complete manganese steel unit has been perfected, comprising accurately fitted pins, bushings and rollers. The rail and shoe are cast integral; the extreme toughness and hardness of manganese steel does not permit of machining, but through perfection of casting and of special grinding processes, all of the parts of the Monarch track links are held to the closest tolerances. This permits of close driving fits in the assembly of the pins and bushings into the track links. The rails are extra high and wide, with openings in the sides and in connection with the special sprocket tooth design and the roller, there is no clogging of the track in sand, mud or snow. Front sprocket release springs of extra heavy type are employed in connection with track adjusting screws.

The new truck roller frame design enables the final drive chains to be enclosed in oil-tight and dirt-proof housings. The housings are made in sections, so as to provide accessible means for inspection of chain and sprockets. The cains are of new extra heavy type especially designed for this service, being made of alloy forged steel, heat treated.

Special consideration has been given to the convenience of the operator. The cushioned seat is wide and comfortable with back rest. The steering column is of truck type with large, easily operated steering wheel. The master clutch lever, located for either right or left as ordered, is within convenient reach, as are the brake pedals, which assist steering. The throttle lever is on the steering column and at the base of the column are located the ignition and lighting switches and the electric starting button. The round, welded fuel tank is mounted back of the motor, and the fuel line to the carburetor is fitted with a gascolator or sediment trap. All air entering the carburetor is filtered through a Pamona air cleaner. The motor is cranked either by the front crank or by the electric starting outfit, or if desired, a Bendix hand starter can be provided on the operators' platform.

Regular equipment includes canopy top, but a full enclosed, metal body cab for winter work can be supplied. The transmission is designed for attachment of power pulley or other type of power take-off in the rear of the case. Detachable grousers of different types are provided for various classes of work. The new model 10-ton Monarch is rated at 59 draw-bar h.p. but develops a maximum of 78 h.p. at the draw-bar.

Over 3,000,000 Miles of Roads in U. S.—There are 3,001,825 miles of roads in the United States, according to the American Road Builders' Association. On Jan. 1, 1928, approximately 666,000 miles had been improved to some degree.